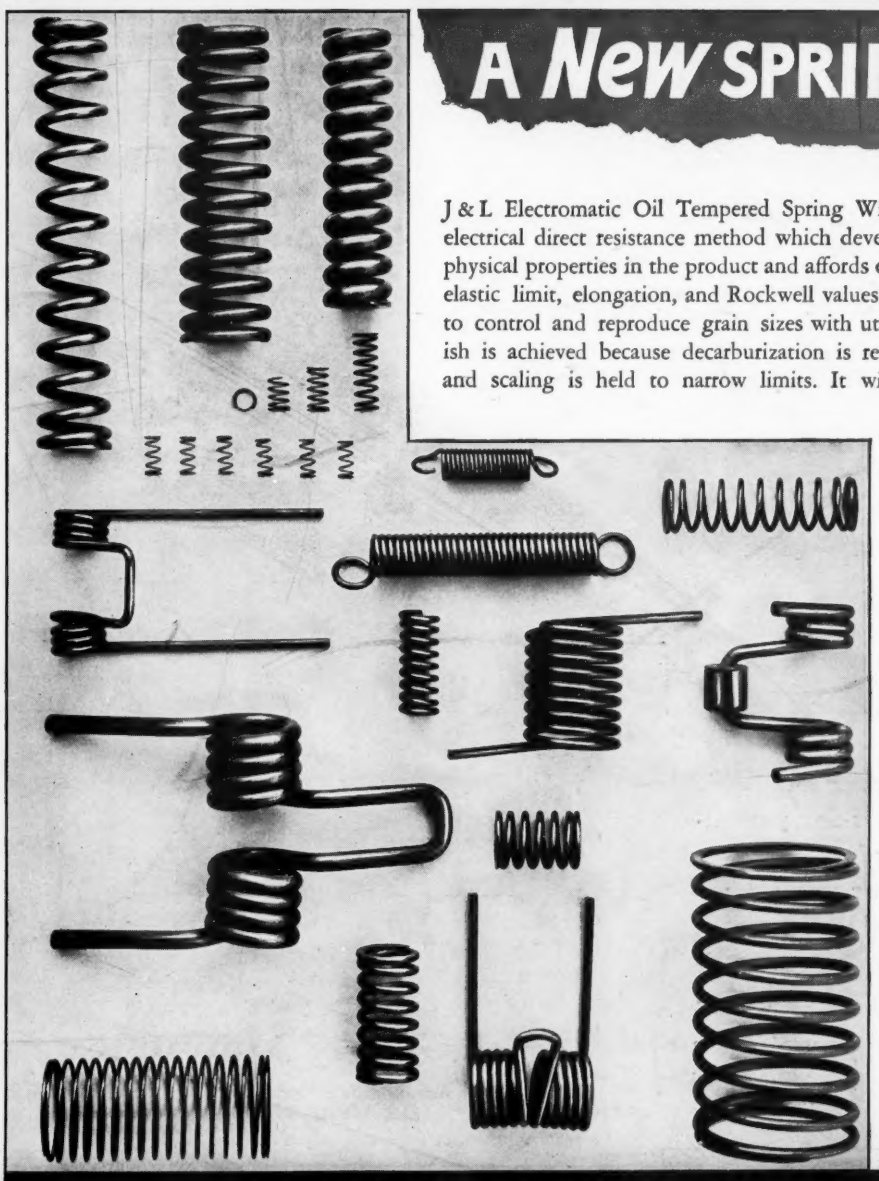
WIRE AND WIRE PRODUCTS

DECEMBER 1940



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← *Typical springs made of*

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AMERICAN IRON AND STEEL WORKS
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OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION

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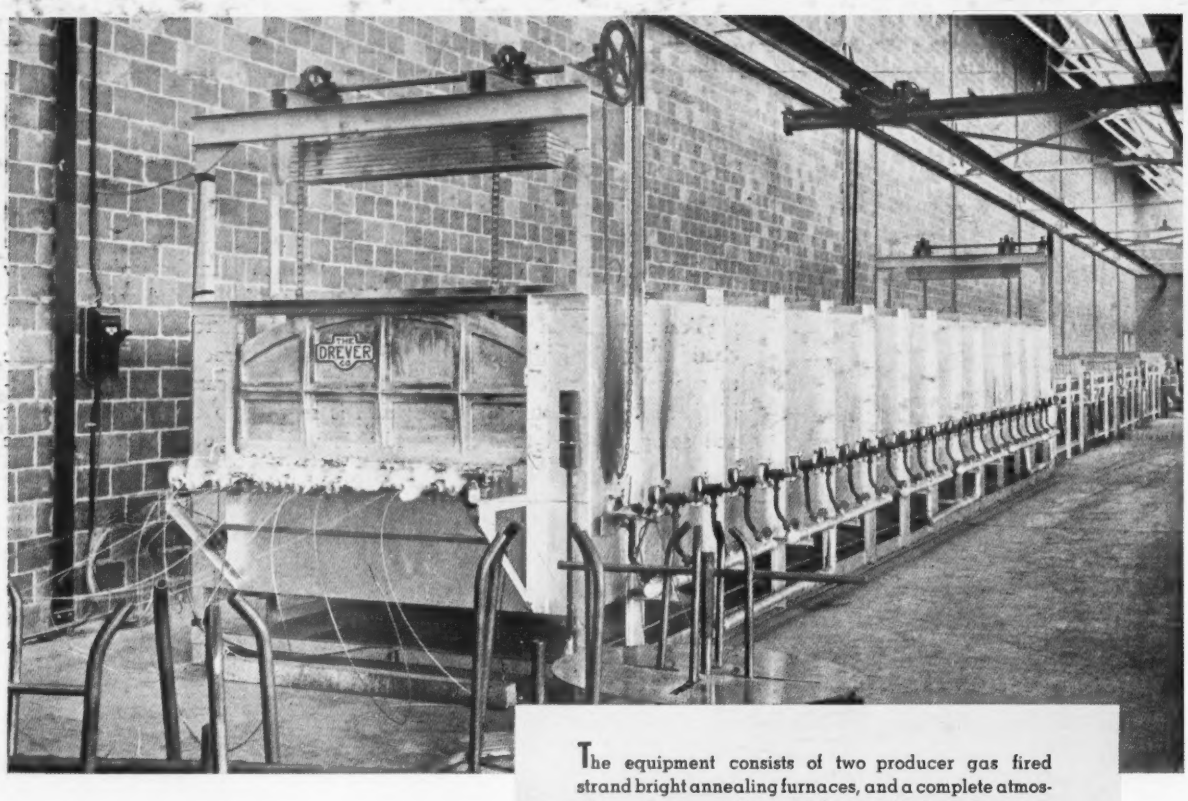

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If you need to Surface Harden Stainless Steels, write for Bulletin on the Drever-Industrial Process

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Why not investigate the possibilities of using bethanized wire in your own plant? It is saving money and improving products for a steadily growing number of manufacturers.

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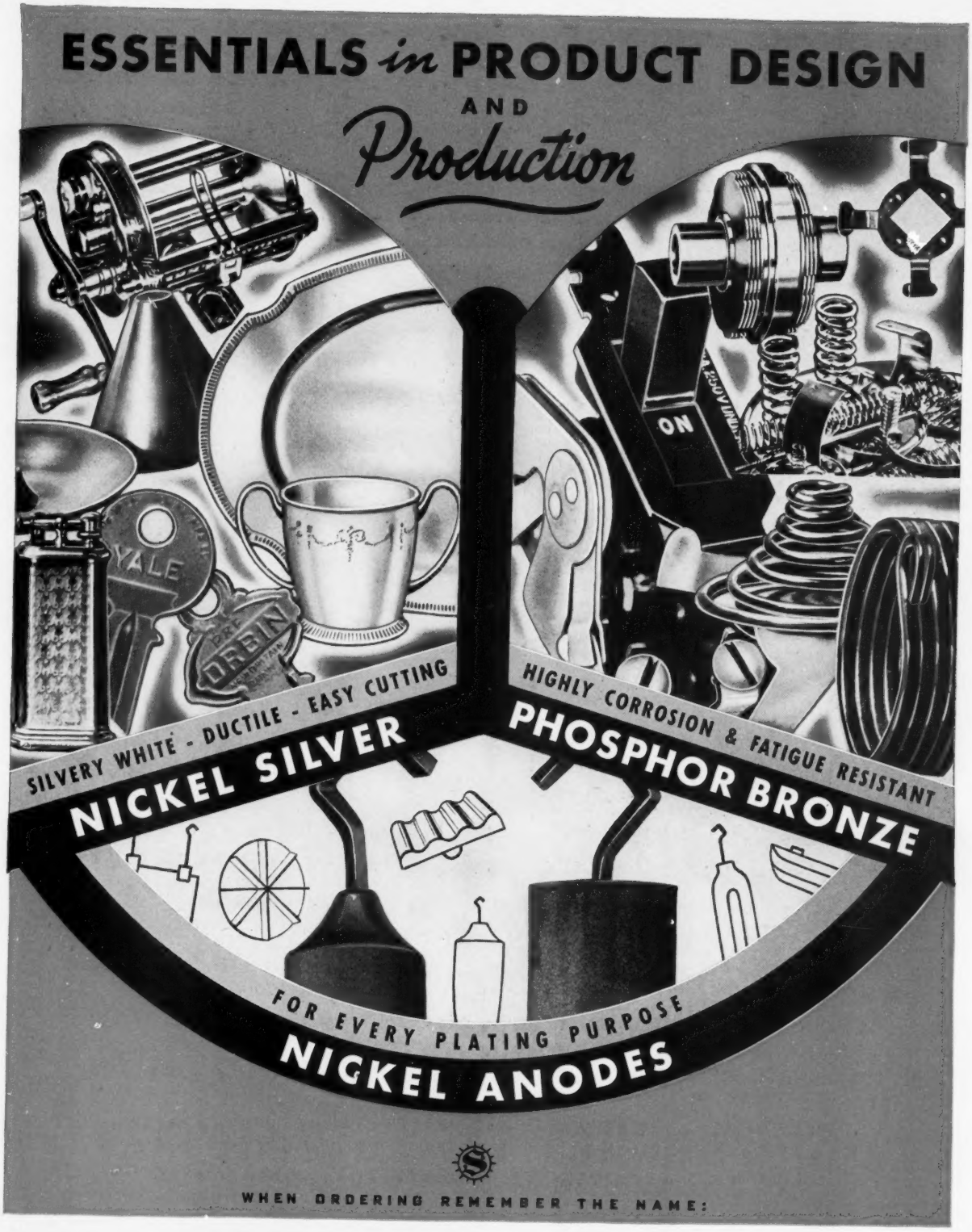

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3 *Higher Finishes Than Are Usually Obtainable*

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By running longer on size, Blue Ribbon Dies require less recutting, less shutdown time for die changes, and a lower die inventory. Compared with either diamonds or regular carbide dies, the overall die cost is substantially lower.

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Blue Ribbon Dies are recommended especially for intermediate fine wire sizes of copper, card wire, book wire, screen cloth wire, music wire, phosphor bronze, stainless steel and many other materials. Being much better, Blue Ribbon Dies cost more—approximately 10%—than corresponding sizes of regular Vascoloy-Ramet Dies. They are available in R-2, R-3 and R-4 nib sizes; rough cored, rough drilled or finished, in quantities of ten or more.

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The discussions on technical papers at the annual meeting of the WIRE ASSOCIATION will be published in their entirety in the regular January issue of WIRE and WIRE PRODUCTS.

✦ ✦ ✦

The Directors of the WIRE ASSOCIATION have approved this plan to provide these discussions to all subscribers without extra expenditure.

✦ ✦ ✦

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By Benjamin Lewis McCarthy
Chief Metallurgist,
Wickwire Spencer Steel Company, Buffalo, N. Y.

On The Subject

"The Use of Plane Polarized Light and Sensitive Tint Illumination in the Analysis of the Microstructure of Steel"

WILL ALSO BE PUBLISHED IN THIS ISSUE

✦ ✦ ✦

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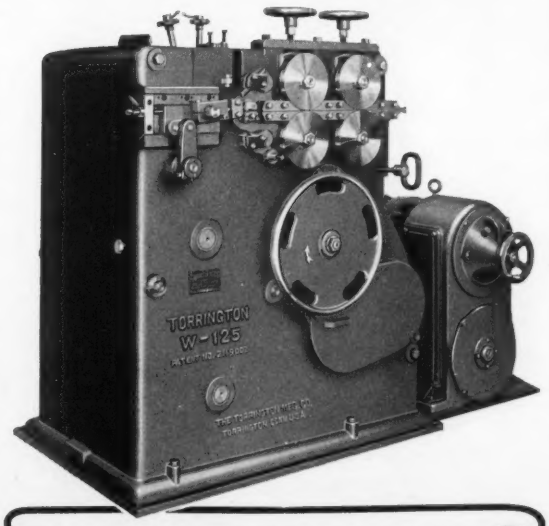

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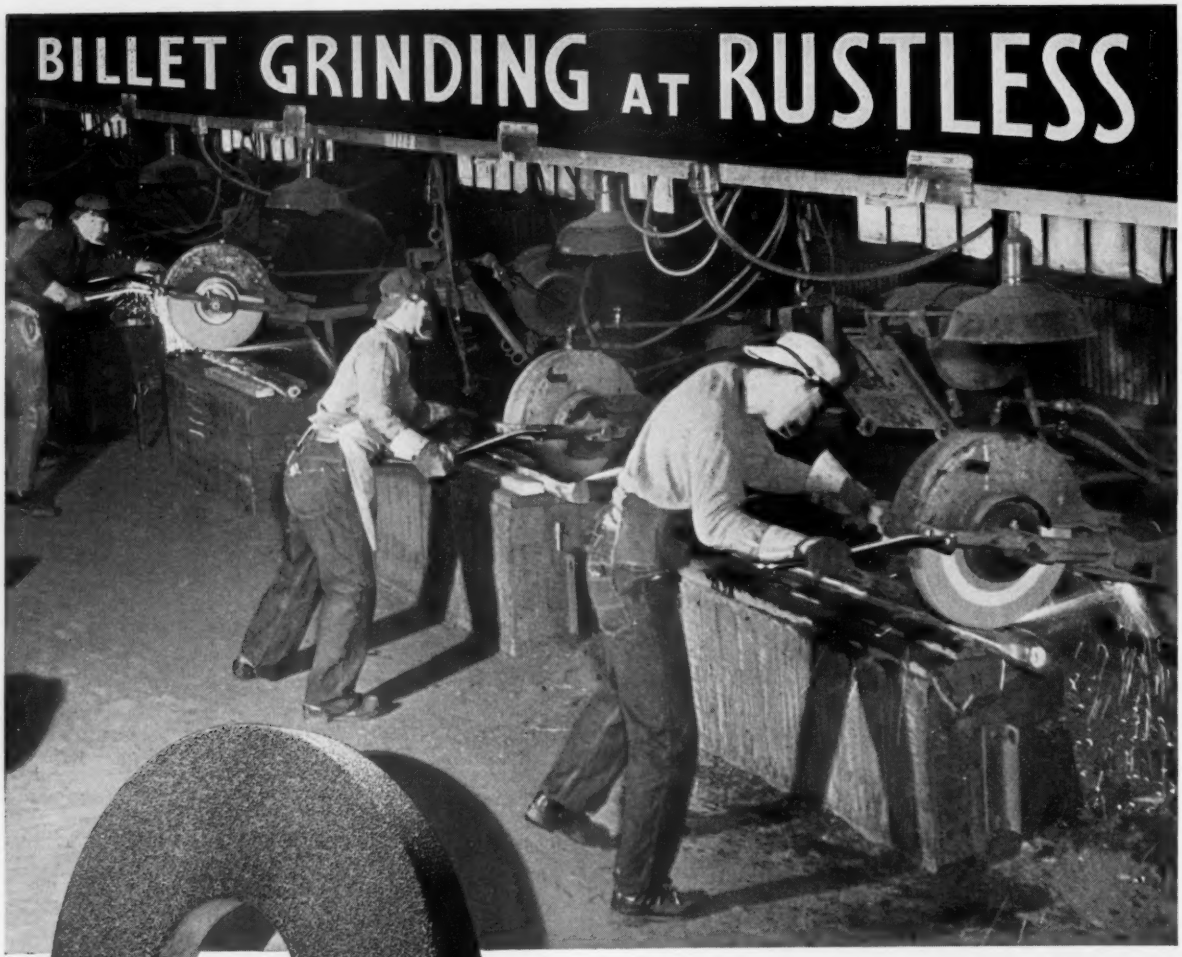

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MODERN—that's the keynote of the new mill of Rustless Iron & Steel Corporation at Baltimore. And the cleaning room is no exception—it is up-to-date in every detail of lay-out and equipment. It is efficient for it includes Norton Grinding Wheels for removing scale and seams from the stainless steel billets.

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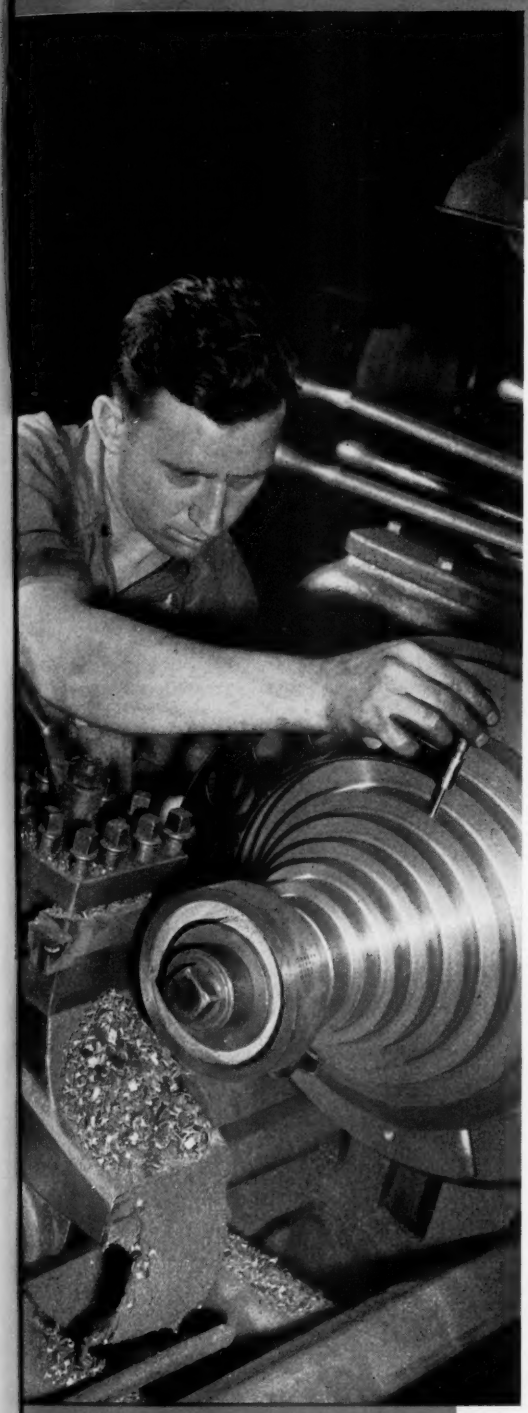

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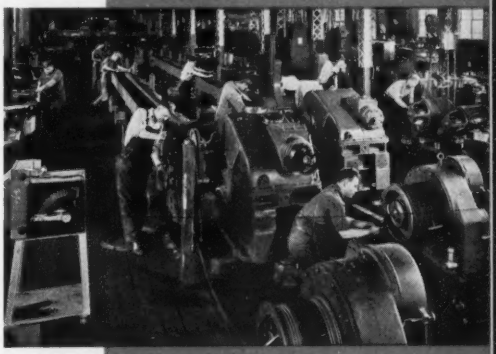
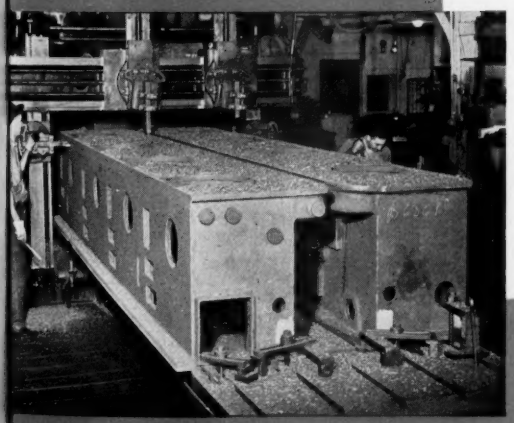
THE WATCHWORD OF EVERY CRAFTSMAN IN THE VAUGHN ORGANIZATION



Precision production tools and split-hair measuring instruments serve the deft hands and keen eyes of the men who build your Vaughn Wire Drawing Machinery. And it's precisely because the Vaughn organization "thinks in thousandths"—from design engineer to final inspector—that you enjoy the smooth, faultless operation of *every* Vaughn machine through so many years of high-speed wire production.

Get the practical facts—a Vaughn representative will gladly discuss them with you.



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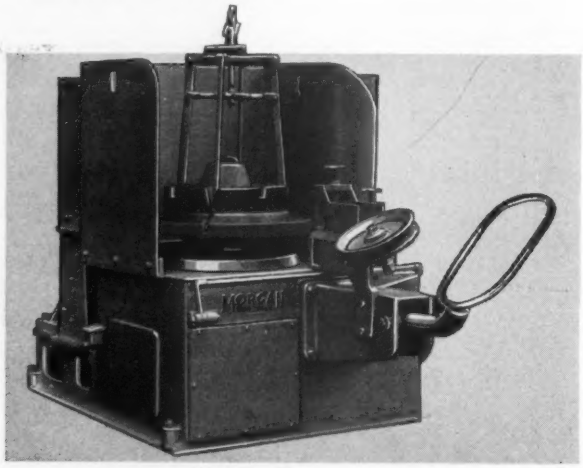
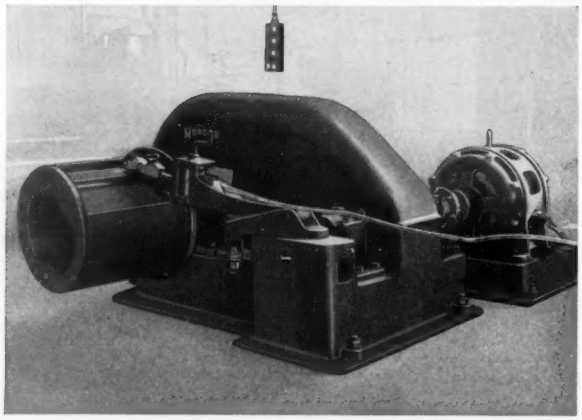
"Bottle Necks," by slowing down the even flow of output, cut into profits -- switch wages from production to overhead. So, it pays to eliminate the bottle necks, many of which can be removed without heavy investment or delay.

Ask for a Morgan Report.





Left: Morgan Wire Block, a compact vertical spindle machine for single draft, or two drafts on double deck blocks. Built in various capacities.
Right: Morgan No. 105 Horizontal Bull Block for coarser sizes, affording highest production and economy through quicker stripping of coils. Block may be 24″ to 36″ as required.

W-56

MORGAN WORCESTER ENGINEERS AND MANUFACTURERS

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MORGAN CONSTRUCTION COMPANY, WORCESTER, MASSACHUSETTS

WIRE AND WIRE PRODUCTS

A monthly publication devoted to the production of Wire, Rod and Strip, Wire and Rod Products and Insulated Wire and Cable

DRAWING—ROLLING—EXTRUDING—FORMING—FABRICATING

Vol. 15 DECEMBER, 1940 No. 12

Designated as

Official Publication By The Wire Association

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Publication Office: Washington, N. J.
Executive Office: Stamford Trust Co. Bldg., 300 Main St., Stamford, Conn.

Annual Subscription, U. S. $5.00, Canada $5.00

50 Cents a Copy in U. S. Issued Monthly Foreign, $7.50

October Convention Issue $1.00 a Copy
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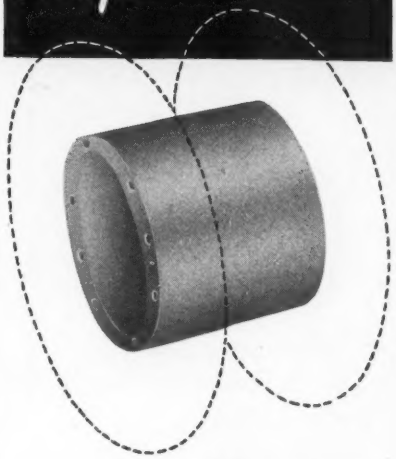
WIRE & WIRE PRODUCTS. Vol. 15, No. 12, December, 1940, Executive Office, 300 Main St., Stamford, Conn. Published by the Quinn-Brown Publishing Corp., Richard E. Brown, President; R. S. Spengel, Secretary and Treasurer. Publication office, 13 West Church Street, Washington, N. J. Subscription price: U. S., $5.00; Canada, $5.00 per year, 50 cents per copy; Foreign, $7.50 per year. Entered as second class mail at the Post Office, Washington, N. J., under Act of March, 1879.

7 cost Reducing Features in Stevens Flanged Steel Drums



(1) Reduces reel assembly costs by eliminating the labor of handling a large number of small parts.

(2) Makes a stronger reel.

(3) Increases number of trips per reel from 50% to 100% before cut downs or complete scrapping of wooden reel heads.

(4) Drums can be used over and over.

(5) Reduces maintenance cost.

(6) Reduces potential hazard of damage to wire and cable in transit and in the field.

(7) As much as fourteen years' service without refinishing or major maintenance.

These statements are taken from actual experience records.

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Ten years ago Firth-Sterling engineers pioneered in developing a new kind of draw die for the wire industry with the early round-hole dies with nibs of Firthaloy Sintered Tungsten Carbide. They represented a vast improvement over the best steel dies ever made!

Thus a new champion was born—a die that could draw more wire in a given time than ever before possible, a die that stayed on size longer, produced vastly superior finishes, reduced drafting costs materially. Today, fully 75% of the nation's wire manufacturing plants are Firthaloy equipped!

New alloys of Tantalum and Titanium have been added to existing Tungsten grades, assuring increasingly better performance. Complete control over production—from the mining of our own tungsten to the Rockwell testing of every nib—results in highest standards of uniformity. Recent price reductions now make possible even wider acceptance and use. Ask a Firthaloy engineer to demonstrate these remarkable dies in your plant.

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WIRE AND WIRE PRODUCTS

A monthly publication devoted to the production of Wire, Rod and Strip.
Wire Products and Insulated Wire and Cable.

DRAWING --- ROLLING --- EXTRUDING --- FORMING --- FABRICATING

Vol. 15 DECEMBER, 1940 No. 12

Galvanizing Characteristics of Different Types of Steel

PART II

By Robert W. Sandelin,
Metallurgist,
Atlantic Steel Co., Atlanta, Ga.

— WIRE ASSOCIATION MEDAL AWARD PAPER - 1940 —

TABLE OF CONTENTS
PART II

Effect of Composition on Coating Weight; Effect of Composition on Coating Microstructure; Summary, Effects of Composition on Coating Properties. ✦ ✦ ✦ ✦

Effect of Composition Upon Weight of Coating

AS previously mentioned, the weight of a galvanized coating is a fair indication of the protection it affords the steel base. Ordinarily however, extremely heavy coatings are not considered economical or practical since ample protection is obtained from lighter weights of coatings. Furthermore extremely heavy coatings are very brittle although brittleness is not necessarily a function of coating weight.

✦ ✦ ✦

DATA resulting from strip tests in order to determine the weight of the coatings on the various steels galvanized for various lengths of time proved to be very interesting in that it was clearly demonstrated that composition played an important role in determining coating weights. At the outset it may be said that both silicon and phosphorus proved to be important factors.

THE hydrochloric acid-antimony chloride method for determining the weight of the zinc coating has been designated as standard by the **American Society for Testing Materials.** Briefly, it consists of removing the zinc coating from an accurately measured and weighed sample by immerson in concentrated hydrochloric acid (sp. gr. 1.19) to which has been added 5 cc of antimony chloride solution to each 100 cc of acid. The antimony chloride solution is prepared by dissolving 20 grams of antimony trioxide in one liter of concentrated hydrochloric acid and is used to inhibit the attack of the acid upon the base metal when the coating has been removed.

✦ ✦ ✦

Series A

THE effect of composition upon the weights of the coatings on the various steels are summarized in Table XXX. These data, produced the curves which are shown in Figures 48 through 52. We note that neither the presence of copper nor manganese has any appreciable effect upon coating weight.

✦ ✦ ✦

THE effect of silicon was interesting in that at .220 per cent silicon the coating weight was the lightest and incidentally, it was at this composition that the steel produced an entirely bright coating at the three minute immersion. As the silicon content was increased the coating weights increased as shown.

✦ ✦ ✦

THE effect of phosphorus at the shorter immersion times indicated a very slight increase in

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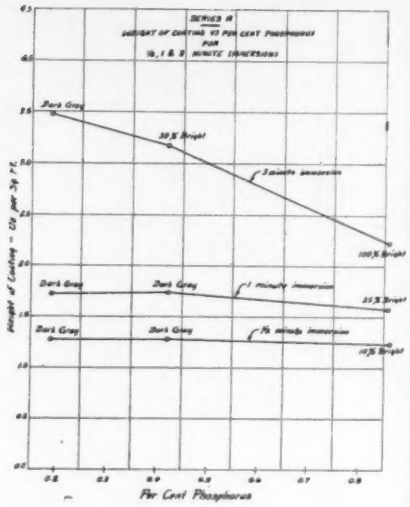


Figure 48

Table XXX
Series A

Base Composition: (Sample 10)	C	P	S	Mn	Cu	Si
	.06	.019	.026	.42	.233	.106

Sample	Analysis	Weight of Coating, Oz./sq. ft. 30 seconds	60 seconds	180 seconds
10	.233% Cu	1.2850	1.7277	3.4894
1	.356% Cu	1.3088	1.7552	3.5261
2	.626% Cu	1.2989	1.7450	3.5112
10	.106% Si	1.2850	1.7277	3.4894
3	.220% Si	1.1238	1.3998	2.2290
4	.348% Si	1.1807	1.5572	3.0315
5	.610% Si	1.2601	1.7388	3.4942
10	.42 % Mn	1.2850	1.7277	3.4894
6	.60 % Mn	1.2815	1.7444	3.4869
7	.84 % Mn	1.3031	1.7520	3.4600
10	.019% P	1.2850	1.7277	3.4894
8	.042% P	1.2984	1.7413	3.1751
9	.086% P	1.2306	1.5743	2.2251

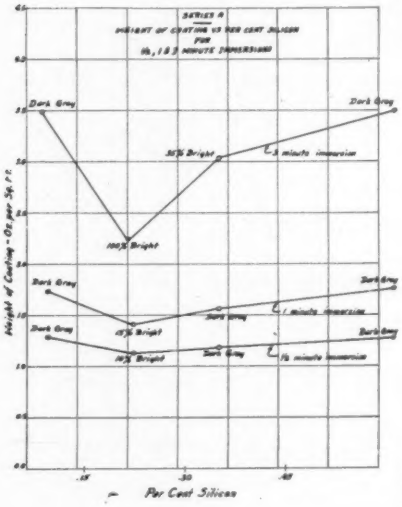


Figure 49

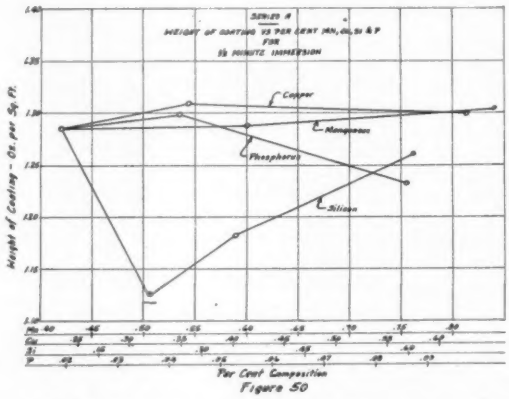


Figure 50

the presence of silicon and vice versa.

✦ ✦ ✦

Series B

AGAIN we note that neither copper nor manganese have any appreciable effect upon the weights of the coatings.

✦ ✦ ✦

THE effect of silicon produced a somewhat different type of curve from Series A, yet a careful analysis of data will reveal that the curves are consistent. The

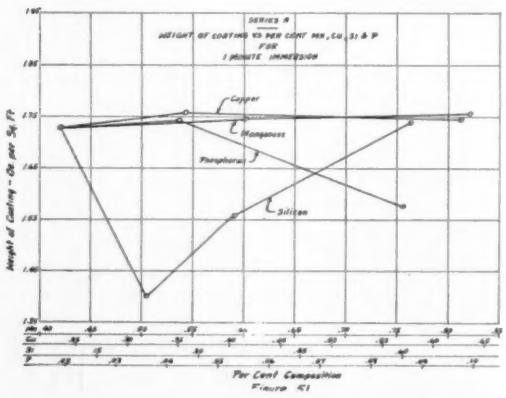


Figure 51

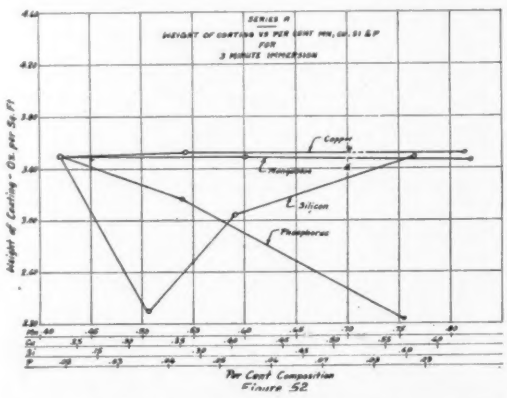
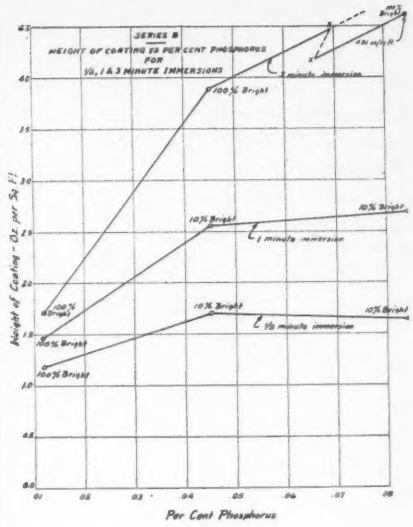


Figure 52

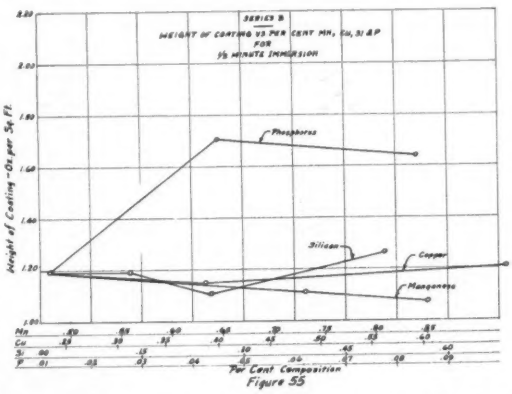
coating weight at the medium phosphorus content, which, however, dropped off with an increase in this element. With an immersion time of three minutes the coating weight dropped off sharply, the falling off in coating weight being much more pronounced than in the cases with shorter immersion times. In this particular instance it is significant to point out that the residual silicon content was .106 per cent. As we shall observe later, the behavior of phosphorus is greatly affected by base composition sample in this series has a low silicon content and as a result, galvanized with a bright spangled coating consisting of a pure zinc layer over the alloy layers. The addition of a slight

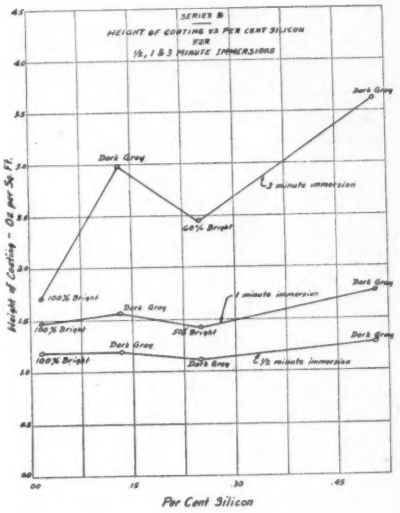
Table XXXI
Series B

Base Composition:		C	P	S	Mn	Cu	Si
(Sample 10)		.17	.019	.032	.48	.235	.015
		Weight of Coating, Oz./sq. ft.					
Sample	Analysis	30 seconds	60 seconds	180 seconds			
10	.235% Cu	1.1957	1.4692	1.7048			
1	.388% Cu	1.1499	1.1793	1.4959			
2	.676% Cu	1.2060	1.3006	1.5501			
10	.015% Si	1.1957	1.4692	1.7048			
3	.132% Si	1.1938	1.5604	2.9859			
4	.249% Si	1.1044	1.4110	2.4467			
5	.508% Si	1.2687	1.7620	3.6137			
10	.48 % Mn	1.1957	1.4692	1.7048			
6	.73 % Mn	1.1119	1.4071	1.5618			
7	.85 % Mn	1.0733	1.3384	1.5655			
10	.019% P	1.1957	1.4692	1.7048			
8	.045% P	1.7049	2.5560	3.8952			
9	.084% P	1.6411	2.6850	4.8179			


SERIES B
WEIGHT OF COATING VS PER CENT PHOSPHORUS FOR ½, 1 & 3 MINUTE IMMERSIONS
Height of Coating - Oz. per Sq. Ft.
Per Cent Phosphorus
Figure 53

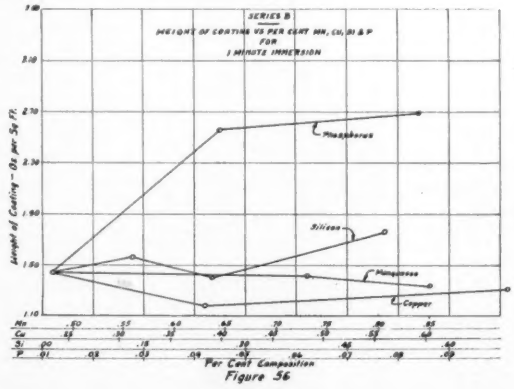
amount of silicon changes the entire appearance and microstructure. The coating becomes a dark gray and consists entirely of iron-zinc alloy layers. Therefore, sample 3 in Series B actually corresponds to sample 10 in Series A. Starting from this point, then, in our comparison we note a striking similarity in the curves. Again we observe that the curve has a minimum value at .249 per cent silicon, which compares favorably with the minimum of .220 per cent silicon in Series A.


SERIES B
WEIGHT OF COATING VS PER CENT Mn, Cu, Si & P FOR ½ MINUTE IMMERSION
Phosphorus
Silicon
Copper
Manganese
Height of Coating - Oz. per Sq. Ft.
Per Cent Composition
Figure 55


SERIES B
WEIGHT OF COATING VS PER CENT SILICON FOR ½, 1 & 3 MINUTE IMMERSIONS
Dark Gray
64% Bright
100% Bright
3 minute immersion
1 minute immersion
½ minute immersion
Height of Coating - Oz. per Sq. Ft.
Per Cent Silicon
Figure 54

immersion although the effect in this series was not as great as in Series A.

✦ ✦ ✦


SERIES B
WEIGHT OF COATING VS PER CENT Mn, Cu, Si & P FOR 1 MINUTE IMMERSION
Phosphorus
Silicon
Manganese
Copper
Height of Coating - Oz. per Sq. Ft.
Per Cent Composition
Figure 56

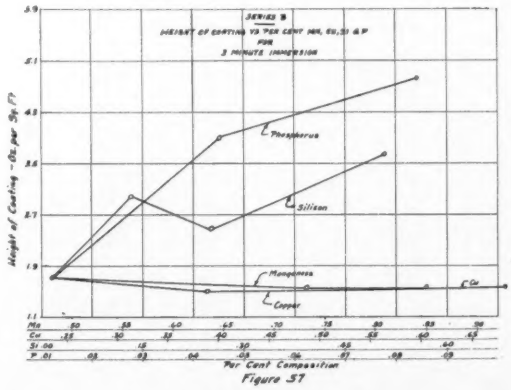


Figure 57

Here again we note that this particular sample had the maximum tendency toward producing a bright coat at the three minute

THE effect of phosphorus in this series as shown by Figures 53, through 57 indicates that increased phosphorus content results in increased coating weights, the effect being very pronounced for long immersions in the spelter. The effect in this series differed

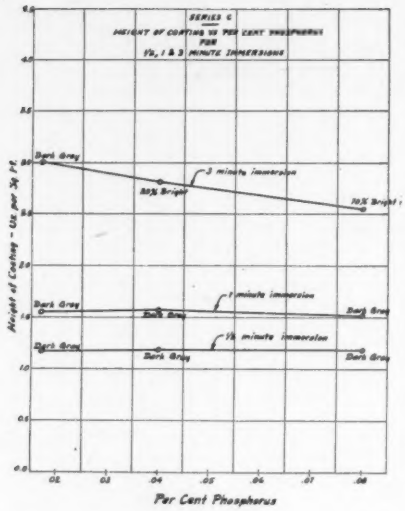


Figure 58

Table XXXII
Series C

Base Composition:	C	P	S	Mn	Cu	Si
(Sample 10)	.32	.017	.027	.50	.191	.127

Weight of Coating, Oz./sq. ft.

Sample	Analysis	30 seconds	60 seconds	180 seconds
10	.191% Cu	1.1761	1.5563	3.0074
1	.358% Cu	1.1901	1.5816	3.0709
2	.600% Cu	1.1838	1.5823	3.0533
10	.127% Si	1.1761	1.5563	3.0074
3	.248% Si	1.1469	1.4994	2.7692
4	.357% Si	1.2272	1.7240	3.7981
5	.625% Si	1.3176	1.8479	3.9561
10	.50 % Mn	1.1761	1.5563	3.0074
6	.69 % Mn	1.1647	1.5611	2.9863
7	.89 % Mn	1.1658	1.5651	2.9540
10	.017% P	1.1761	1.5563	3.0074
8	.040% P	1.1932	1.5731	2.8092
9	.080% P	1.1809	1.5133	2.5475

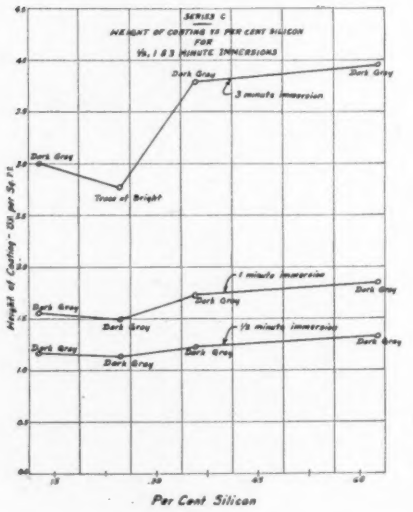


Figure 59

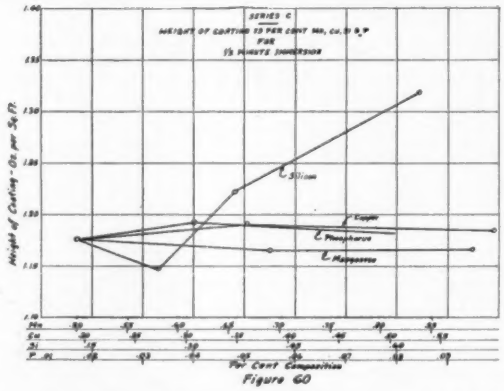


Figure 60

creased phosphorus content increases the weight of the coating tremendously provided no silicon is present. If silicon is present,

Series C

VARIATION in copper and manganese contents is without any appreciable effect hence one may conclude that the presence of varying amounts of these elements are of no practical importance. Of course negative results do have importance as such, they are, however, less effective in creating interest than data of a positive nature.

✦ ✦ ✦

THE effect of silicon was consistent with results obtained

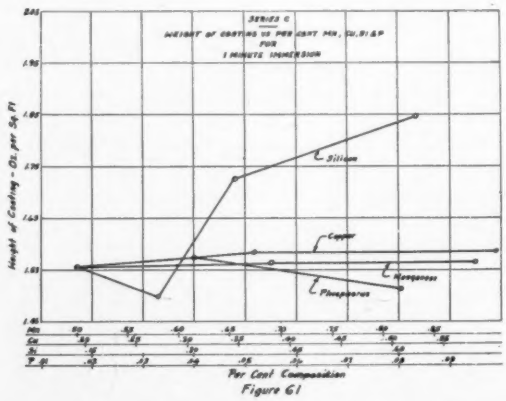


Figure 61

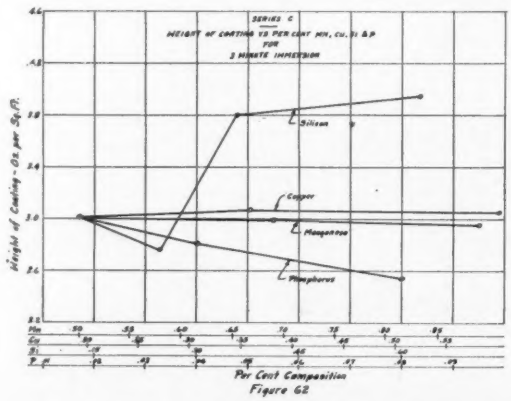


Figure 62

from that observed in Series A, however in this instance the residual silicon content was extremely low and this factor is an important consideration. In other words, in the weight of the resultant coating is considerably less, particularly for long immersions. Table XXXI summarizes data obtained on this series.

in Series A and B. Figures 58 through 62, illustrate this effect showing a minimum point in the curves at .248 per cent silicon. Increasing the silicon content above

Table XXXIII
Series E

Base Composition: (Sample 12)	C .11	P .015	S .028	Mn .42	Cu .175	Si .0090

Weight of Coating, Oz./sq. ft.

Sample	30 seconds	60 seconds	180 seconds
12	1.1396	1.1670	1.4137
1	1.8074	2.6907	5.2847
2	1.2359	1.2794	1.7099
3	1.2525	1.3169	1.5309
4	1.2243	1.7397	3.5957
5	1.2246	1.7477	3.6075
6	1.2379	1.7484	3.6289
7	1.1268	1.6041	3.3663
8	1.7161	2.4617	5.0737
9	1.1452	1.6266	3.4123
10	1.7520	2.5505	5.2513
10 S	1.3676	1.5815	1.7092
11	1.1808	1.6454	3.4167

this value causes a very marked increase in coating weight. In comparing the curves for silicon in Series A, B, and C we note that with an increase in carbon content, the 'dip' in the curve becomes much less pronounced. Whether or not the carbon content is the sole factor in affecting this change in the curves for these steels is not conclusive.

✦ ✦ ✦

THE effect of phosphorus in this series was quite similar to the results observed in Series A. The general character of the curves were the same except that the decrease in coating weight was not so pronounced. Here again we must take into account the fact this series of steels contained a residual silicon content of .127 per cent, the presence of which has a profound effect upon the behavior of the phosphorus.

✦ ✦ ✦

Series E

SINCE the role of copper is more or less ineffectual in affecting the coating weight it will not be given further consideration in this series. The most interesting and important data obtained in this set was obtained from the phosphorus-silicon combinations. Figures 63 through 68 show the effects of phosphorus, silicon and combinations of the two.

✦ ✦ ✦

SINCE the base composition of this series contained only .0090 per cent silicon, the effect of increasing the phosphorus content was to increase the weights of the coatings tremendously, particularly for the three minute immersion.

✦ ✦ ✦

THE effect of increasing the silicon content to the high values indicated was to increase the coating weights slightly at the thirty second immersion, considerably more at the one minute immersion and about 300 per cent at three minute immersion. Nevertheless, the increase in coating weight due to silicon alone was considerably less than for the high phosphorus samples which showed coating weight increases of about 350 per cent for the 3 minute immersion. This seems astounding when compared with the 24 per cent increase of the base sample for the three minute immersion.

✦ ✦ ✦

THE effect of increasing the silicon content to the high values indicated, produced large increases in coating weight over the base sample; the per cent increase due to silicon average 7.84, 49.6 and 155.3 per cent respectively for the ½, 1 and 3 minute immersion when compared with the coating weights of the base sample for the corresponding immersion time. Combining the effect of composition and immersion time the total average increase due to

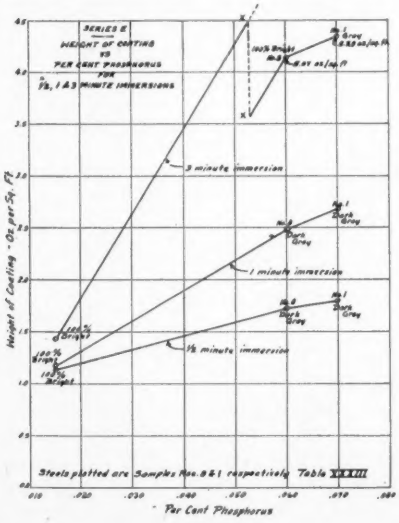


Figure 63

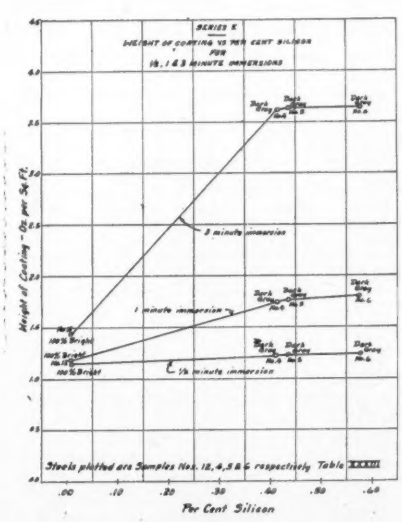


Figure 64

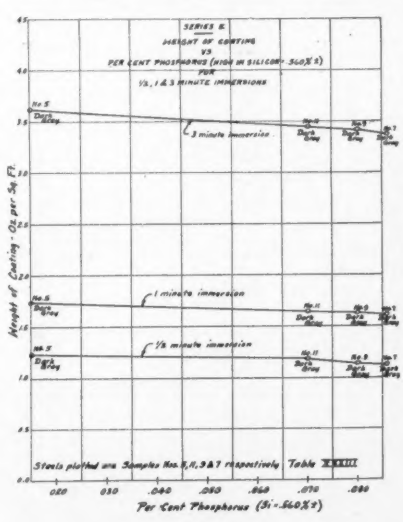


Figure 65

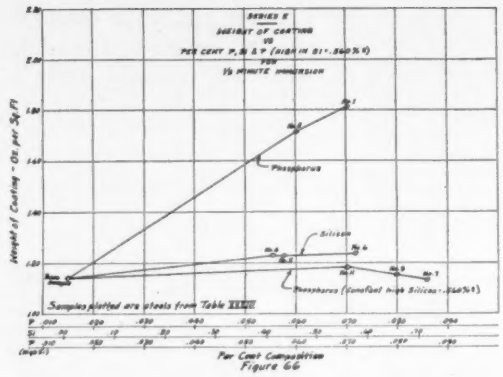


Figure 66

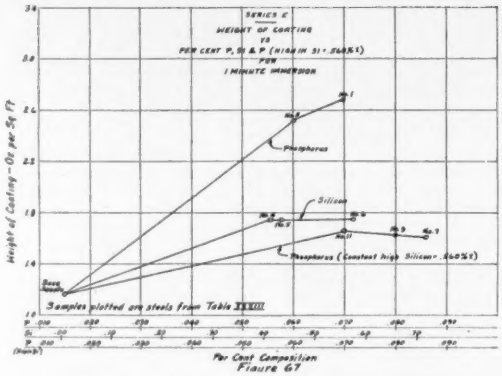


Figure 67

silicon over the base sample at ½ minute immersion amounted to 217 per cent.

✦ ✦ ✦

SINCE no intermediate silicon contents were included in this series the 'dip' in the curve in the neighborhood of .20 and .30 per cent silicon was not revealed.

✦ ✦ ✦

THE combined effect of high phosphorus and high silicon contents was to decrease the coating weights below the values of either the phosphorus or silicon alone. The curves illustrating this effect are shown in Figures 66, 67 and 68. It seems apparent that silicon exerts a retarding effect upon high phosphorus steels and vice versa; this effect was previously noted in Series A and C. Note however that the coating weight values are considerably higher than those observed in Series A and C. This suggests that the amount of silicon present

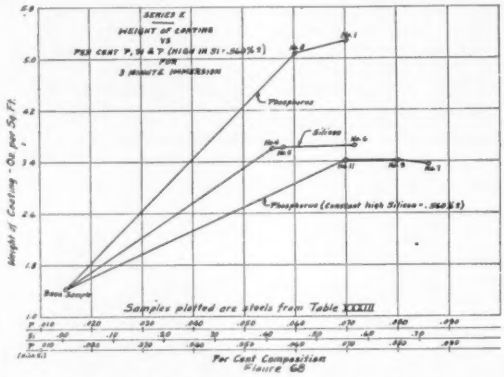


Figure 68

in a high phosphorus steel affects the coating weight, the greater the amount of silicon, the greater the coating weight for a given phosphorus content.

✦ ✦ ✦

IN this regard it is interesting and indeed timely to introduce certain data from Series D the base composition of which was similar to Series E except for a higher residual copper content. The phosphorus-silicon samples contained considerably less silicon than the corresponding samples in Series E and are introduced at this point to produce additional data substantiating the fact that the amount of silicon present affects the coating weights for such combinations.

✦ ✦ ✦

THE coating weights on the high - phosphorus steels appear normal for a steel low in silicon. The coating weights on the silicon steels are quite low when compared with the silicon steels in Series E, however, it must be remembered that in this particular instance the silicon contents are in the range of the minimum point for straight silicon steels, hence the values are low as the range of .20 to .30 per cent silicon is approached. This corresponds to trends in coating weights observed in Series A, B and C.

✦ ✦ ✦

Table XXXIV
Series D

Base Composition:	C	P	S	Mn	Cu	Si
(Sample 14)	.10	.011	.024	.44	.310	.0094

		Weight of Coating, Oz./sq. ft.		
Sample	Analysis	30 seconds	60 seconds	180 seconds
14	.011% P, .0094% Si	1.1839	1.2558	1.5093
10	.066% P, .0094% Si	1.6611	2.4717	5.2213
11	.079% P, .0094% Si	1.6753	2.5115	5.2750
4	.087% P, .0094% Si	1.7523	2.5503	5.4884
6	.173% Si, .011% P	1.1905	1.5723	3.1756
9	.181% Si, .011% P	1.1809	1.4600	2.4657
1	.214% Si, .011% P	1.1267	1.3942	2.2711
13	.187% Si, .079% P	1.1274	1.4757	2.3939
8	.196% Si, .067% P	1.2538	1.5277	2.7822

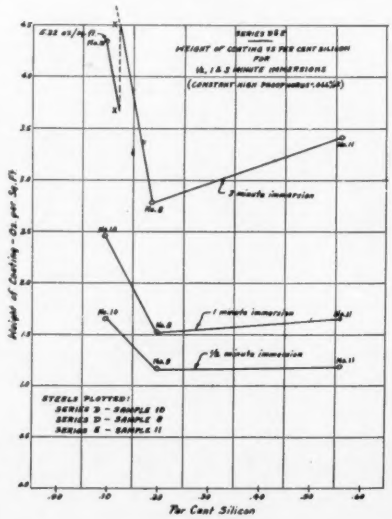


Figure 69

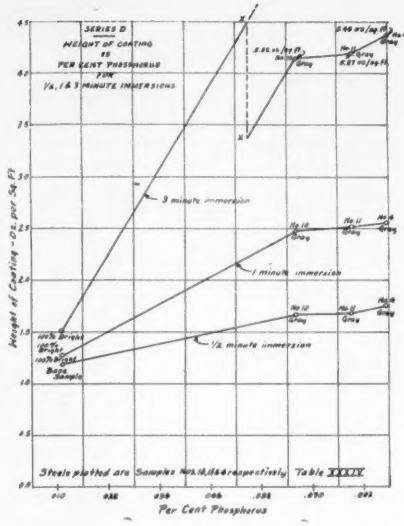

SERIES D
WEIGHT OF COATING VS PER CENT PHOSPHORUS FOR 1/2, 1 & 3 MINUTE IMMERSIONS
3 minute immersion
1 minute immersion
1/2 minute immersion
Steels plotted are Samples Nos. 10, 11 & 4 respectively Table XXXIV
Height of Coating - Oz. per Sq. Ft.
Per Cent Phosphorus

Figure 70

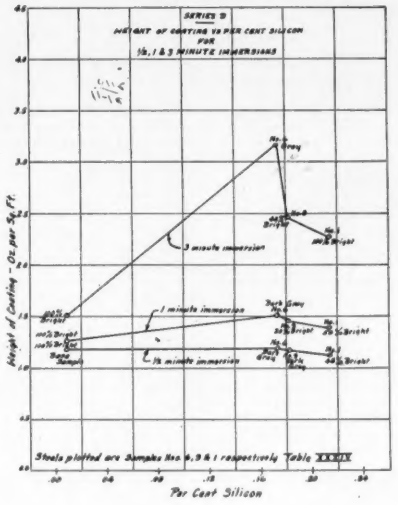

SERIES D
WEIGHT OF COATING VS PER CENT SILICON FOR 1/2, 1 & 3 MINUTE IMMERSIONS
3 minute immersion
1 minute immersion
1/2 minute immersion
Steels plotted are Samples Nos. 6, 9 & 1 respectively Table XXXIII
Height of Coating - Oz. per Sq. Ft.
Per Cent Silicon

Figure 71

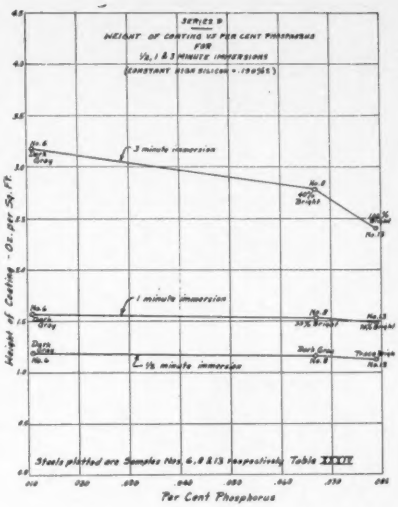

SERIES D
WEIGHT OF COATING VS PER CENT PHOSPHORUS FOR 1/2, 1 & 3 MINUTE IMMERSIONS
(CONSTANT HIGH SILICON = .190%)
3 minute immersion
1 minute immersion
1/2 minute immersion
Steels plotted are Samples Nos. 6, 9 & 13 respectively Table XXXIII
Height of Coating - Oz. per Sq. Ft.
Per Cent Phosphorus

Figure 72

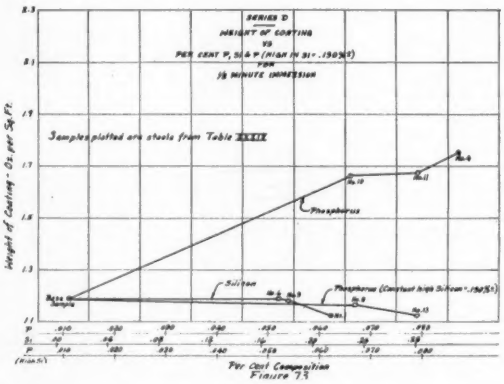

SERIES D
WEIGHT OF COATING VS PER CENT P, Si & P (HIGH IN Si = .190%) FOR 1/2 MINUTE IMMERSION
Samples plotted are steels from Table XXXIII
Phosphorus
Silicon
Phosphorus (Constant high Silicon = .190%)
Height of Coating - Oz. per Sq. Ft.
Per Cent Composition

Figure 73

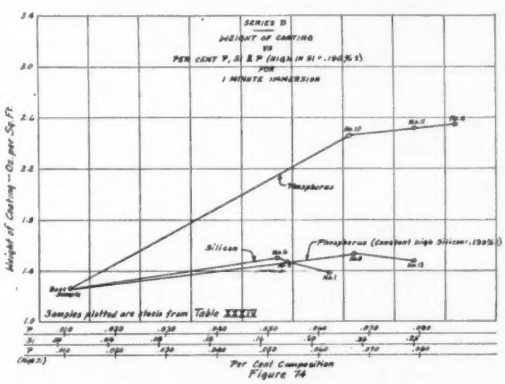

SERIES D
WEIGHT OF COATING VS PER CENT P, Si & P (HIGH IN Si = .190%) FOR 1 MINUTE IMMERSION
Phosphorus
Silicon
Phosphorus (Constant high Silicon = .190%)
Samples plotted are steels from Table XXXIII
Height of Coating - Oz. per Sq. Ft.
Per Cent Composition

Figure 74

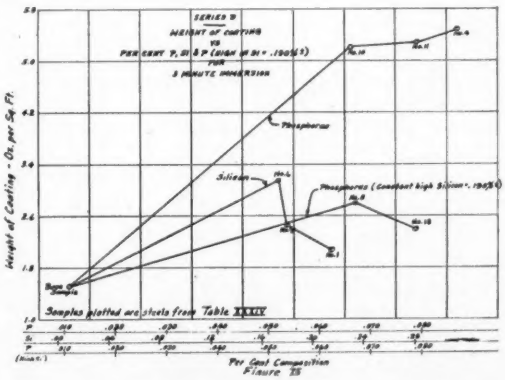

SERIES D
WEIGHT OF COATING VS PER CENT P, Si & P (HIGH IN Si = .190%) FOR 3 MINUTE IMMERSION
Phosphorus
Silicon
Phosphorus (Constant high Silicon = .190%)
Samples plotted are steels from Table XXXIII
Height of Coating - Oz. per Sq. Ft.
Per Cent Composition

Figure 75

IN the case of the phosphorus - silicon combinations, the silicon content has an effect corresponding to the residual silicon content found in Series A and C and hence the results should be similar in effect. This we find to be the case, the coating weights dropping off with increased phosphorus content for a given silicon content. This corresponds in effect to the dropping off of coating weights in Series A and C for the so-called straight phosphorus steels which in reality contained residual silicon, enough in fact, to have a marked influence upon the results. In Series E the silicon content was much higher in the Si-P steels than in Series D and the effect was to increase the coating weight. This seems to be in order when one considers the fact that on the straight silicon steels the highest coating weights were obtained with the highest silicon steels, whereas the lowest values were obtained in the range .20 to .30 per cent silicon. It appears that for a given phosphorus content, either high or low, the effect maintains itself, that is, the highest coating weights are obtained with the high silicon steels and the lowest coating weights are obtained in the region .20 to .30 per cent silicon. This effect on high phosphorus steels is easily made by plotting samples 10, and 8, Series D; and sample 11, Series E as shown in Figure 69. The same effect of silicon on low phosphorus steels was previously illustrated by the silicon curves in Series A, B and C.

✦ ✦ ✦

ALSO as previously mentioned, we note, in comparing the Si-P steels in Series D and E, that for a given silicon content the coating weights decrease with increased phosphorus content. This in effect is the same trend observed in Series A and C, hence we may conclude that this effect holds for all ranges of silicon excepting extremely low values, possibly under .05 or .06 per cent.

✦ ✦ ✦

FIGURES 70 through 75 show graphically the effects of composition versus coating weights in Series D.

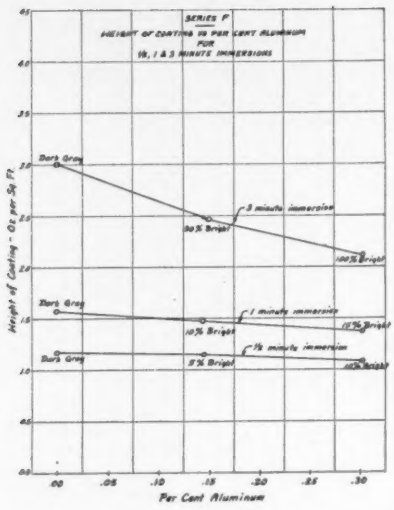


Figure 76

Table XXXV
Series F

Base Composition: (Sample 8)	C .05	P .011	S .026	Mn .45	Cu .229	Si .120

Sample	Analysis	Weight of Coating, Oz./sq. ft. 30 seconds	60 seconds	180 seconds
8	.05% C	1.1779	1.5870	3.0009
1	.20% C	1.1964	1.5843	3.1013
2	.35% C	1.1714	1.5695	3.1303
8	.000% Ti	1.1779	1.5870	3.0009
3	.042% Ti	1.1805	1.5736	2.9342
4	.100% Ti	1.1813	1.5956	2.8610
5	.169% Ti	1.1501	1.5331	2.6956
8	Trace Al	1.1779	1.5870	3.0009
6	.145% Al	1.1508	1.4891	2.4661
7	.303% Al	1.0927	1.3839	2.1101

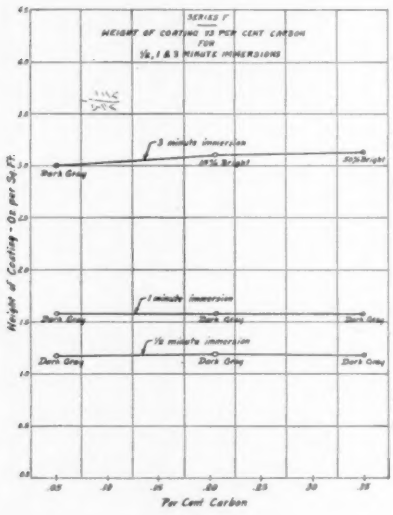


Figure 77

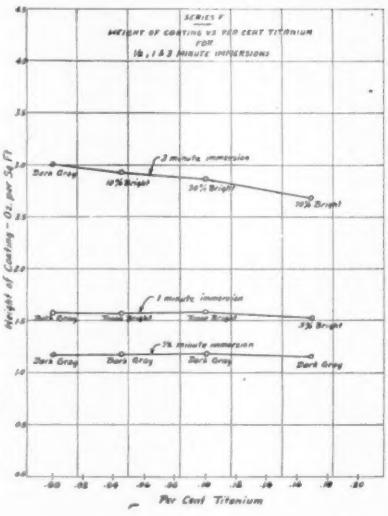


Figure 78

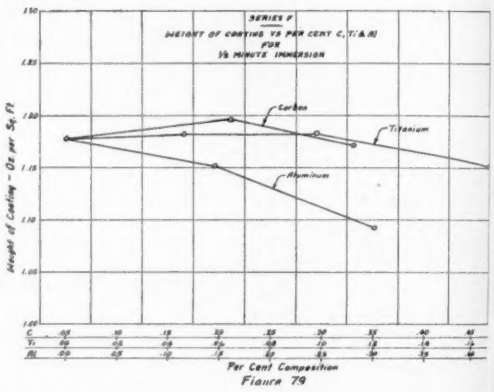


Figure 79

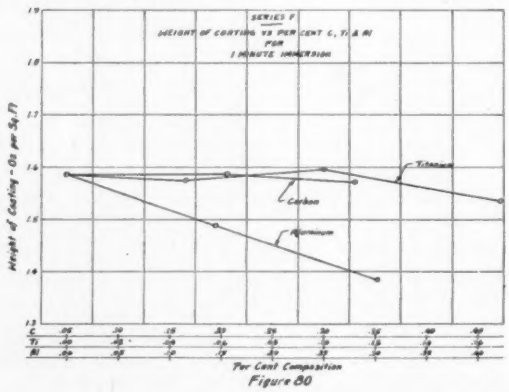


Figure 80

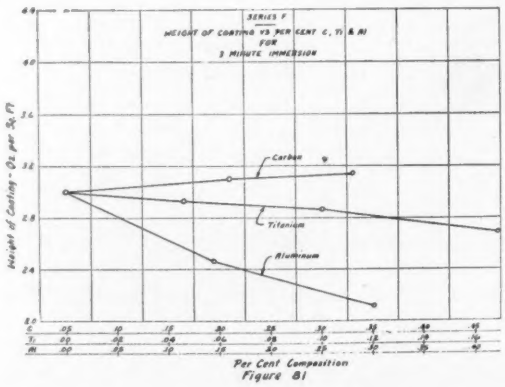


Figure 81

Series F

THE effect of carbon content on coating weights was apparently without appreciable importance, at least in the range investigated. The slight variations observed were of such small magnitude as to be negligible.

✦ ✦ ✦

THE effect of increasing titanium was without marked effect, the general tendency appearing to be that of decreasing the coating weight slightly with increased amounts of titanium.

✦ ✦ ✦

THE effect of high aluminum additions was interesting. The

Table XXXVI
Series G

Base Composition:	C	P	S	Mn	Cu	Si
(Sample P-1)	.10	.099	.035	.39	.292	.218

Weight of Coating, Oz./sq. ft.

Sample	Analysis	30 seconds	60 seconds	180 seconds
P-1	.218% Si	1.1533	1.5585	2.6088
P-2	.500% Si	1.1793	1.6558	3.4083

Table XXXVII
Series H

Individual Heats

Weight of Coating, Oz./sq. ft.

Sample	30 seconds	60 seconds	180 seconds
B-1	1.1429	1.2817	1.4988
B-2	1.7339	2.8412	3.7715
B-3	1.1948	1.5622	2.2800
B-4	1.1837	1.5875	2.9640
B-5	1.1264	1.4338	2.2876
R-1	1.1639	1.2704	1.5344
R-2	1.0818	1.1987	1.5025
S-1	1.1991	1.6130	3.1227

weights of the coatings dropped off considerably with increasing amounts of aluminum, being most marked at the three minute immersion. In this regard it is interesting to point out the fact that the three minute samples were bright and spangled.

✦ ✦ ✦

FIGURES 76 through 81 show the effects of these additions upon the weights of the galvanized coatings.

✦ ✦ ✦

Series G

THE effect of increasing the silicon content from .218 to .500 per cent on a very high phosphorus steel produced increased coating weights for all immersions. The effect was most pronounced at the three minute immersion. Table XXXVI shows the effect of this silicon addition upon coating weight.

✦ ✦ ✦

Series H

THIS series was comprised of separate heats, chosen because of suitable analyses for comparison with the other series. It was thought that perhaps the effects brought about by mold additions would not be comparable with effects observed in individual heats of varying composition. Sufficient data are already on hand to dispel any concern regarding this matter. However, the results will be summarized and illustrated graphically.

✦ ✦ ✦

TABLE XXXVII shows the coating weights obtained with the various steels. From these data one can observe the remarkable inhibiting effect toward heavy coatings exhibited by the low silicon, low phosphorus steels, B-1, R-1 and R-2, the latter two steels being of the rimmed variety.

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THE effects of varying phosphorus and silicon contents were the same as observed in previous series.

✦ ✦ ✦

THE single high sulphur steel produces coating weight similar to those obtained in plain carbon steels for the same silicon content, hence we conclude that the predominant effect is that due to silicon and that sulphur is not in the same category with phosphorus in affecting coating weights.

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Summary: Coating Weights vs. Composition

THE effects of composition upon the weights of the resultant galvanized coatings are summarized in the following:

1. **Copper has no appreciable effect upon coating weights.**
2. **Manganese has no appreciable effect upon coating weights.**
3. **Silicon varies in its effect depending upon the residual silicon in the base composition, two effects are noted, they are:**
   - **(a) In silicon-killed steels having a residual silicon content of .10 to .15 per cent silicon, the effect of increased silicon is to decrease coating weights in the range of .20 to .30 per cent silicon. Increased amounts of silicon produce heavier coatings.**
   - **(b) In semi-killed steels or steels very low in silicon, the effect of the initial increase in silicon is to increase the coating weight up to about .15 per cent silicon. Further increases in silicon then cause a dropping off in coating weight as the range .20 to .30 per cent is approached. Further increases above this range then produce increased coating weights. In other words, the first addition of silicon changed the steel to a silicon-killed steel, from which point it behaves like any other silicon-killed steel.**
4. **The effect of phosphorus is profoundly affected by the presence of residual silicon, that is to say, whether or not the steel was silicon-killed. The effect of phosphorus exhibits the following behavior depending upon the residual silicon content, thus:**
   - **(a) In silicon-killed steels, the effect of increased phosphorus is to decrease coating weights.**
   - **(b) In steels very low in silicon, possibly under .05 per cent, the effect of increased phosphorus is to increase coating weights tremendously, particularly for long immersions.**
5. **The effect of phosphorus and silicon combined, depends upon the amounts of silicon and phosphorus present, thus:**
   - **(a) For a given silicon content, the effect of increased phosphorus is to decrease the coating weight. The higher the silicon content, the greater will be the weights of the coating. The lowest values are obtained with the silicon content in the range .20 to .30 per cent silicon.**
   - **(b) For a given phosphorus content, high or low, the behavior of silicon appears to be the same, namely, the lowest values are found in the region of .20 to .30 per cent silicon. In other words, curves showing coating weights versus silicon content have their minimum values in this particular range regardless of the phosphorus content.**
6. **The effect of increased carbon content is without appreciable effect in the range investigated.**
7. **The effect of increased amounts of titanium appears to be negligible except for long immersions which tend**

to show that increased amounts of this element decreases slightly the coating weight.

8. Increased amounts of aluminum cause a marked decrease in coating weight most pronounced at long immersions.

✦ ✦ ✦

THE conclusions mentioned above in regard to carbon, titanium and aluminum are based on additions made to a silicon-killed steel.

✦ ✦ ✦

Metallographic Characteristics of the Various Types of Galvanized Coatings

IT is undoubtedly true that the various properties of a hot-dip galvanized coating, such as appearance, adherence and weight, are closely related to its microstructure. It seems reasonable, therefore, to assume that the microstructure of a bright, spangled coating differs from that of a gray coating, and, such is indeed the case. Since the various types of coatings vary with the different types of steels being galvanized, it can be assumed that the microstructure is greatly influenced by and is a function of the composition of the steel base when galvanized under comparable conditions. **Finkelday (13)** in his work on the microstructure of zinc coatings mentions the fact that he believed the various types of coatings he obtained were due in part to differences in composition of the steel base. No attempt was made however, to correlate these structures with composition.

✦ ✦ ✦

IN this portion of the work, it is endeavored to show, and point out differences in the characteristic microstructures for coatings on the various classes of steels. In order to do this, all of the samples for each immersion time were mounted, polished, etched and examined under the metallographic microscope.

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THE method of procedure for preparing each of the 216 specimens is discussed briefly in the following: A small, ¾ inch portion was cut from the top of each galvanized sample and mounted in bakelite using a press operating at 300°F and about 3000 lbs. per square inch. This procedure insured examination of all specimens from the same relative position in the test sample thus producing comparable results.

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THE sample, mounted in bakelite, was ground to flatness on a machine grinder, then polished by hand on 1, 1/0, 2/0, 3/0 metallographic polishing paper, and finally placed on horizontal rotating polishing wheel covered with broadcloth.

✦ ✦ ✦

SINCE the pure zinc layers in the coatings were very thin the use of rouge suspended in water was quite unsatisfactory. In practically every case where water was used the pure zinc layer over the alloy layers would pit so badly as to be practically indiscernible under the microscope. A dark band representing the area formerly occupied by the pure zinc was about all that could be observed after polishing. After considerable delay it was decided to try the method suggested by **Romig and Rowland (14)** of using rouge suspended in ethylene glycol monobutyl ether. This method preserves the pure zinc layer even when very thin, and proved to be a decided improvement over the conventional method. **Romig and Rowland** recommended an etching reagent composed of 8 drops of concentrated HNO_3, 4 drops of concentrated HF, and 30 ml of glycerine. It was found that while this etching reagent was satisfactory it reacted rather slowly and did not develop the iron-zinc alloy structures quite as sharply as one comprised of the following: 10 grams Cr_2O_3, 1.5 grams Na_2SO_4, 100 cc water, etching time one to three seconds. Both of these etching reagents were too strong for developing the very thin pure-zinc layer, being over-etched very readily. It was found that in order to prevent over-etching and develop these thin layers in a satisfactory manner it was necessary to dilute the chromic acid etching reagent described above to a very low strength. A few drops in an ordinary watch glass filled with water reduced its reaction rate so that a satisfactory etching time for the pure-zinc layer was of the order of from 8 to 12 seconds. At this dilution it was not possible to completely develop the microstructures of the alloy layers, however, in these cases the identification of the pure-zinc layer was the primary objective.

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DUE to the tremendous difference in hardness between the pure-zinc layer, iron-zinc alloy layer and steel base it was particularly difficult to obtain good polishes where it was desired to

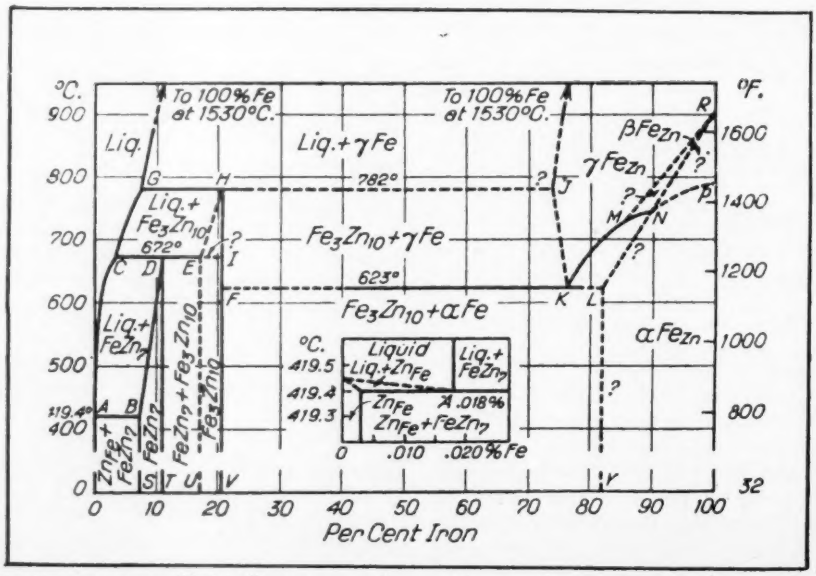

Fig. 193. Iron-zinc equilibrium diagram.

show the pure-zinc layer. In most cases this layer was very thin and was revealed only with considerable difficulty. With increasingly heavier coatings, the pure-zinc layer becomes more easily identified.

✦ ✦ ✦

Interpretation of the Iron-Zinc Equilibrium Diagram

INTERPRETATION of the iron-zinc equilibrium diagram reveals the existence of two intermetallic compounds and a simple solid solution of iron in zinc. The amount of iron held in solution in the zinc seems to be a controversial issue, the amount ranging from 0.0028 to 0.020 per cent. Recent work, (15), seems to indicate that the former figure is probably more nearly correct.

✦ ✦ ✦

FIGURE 193 shows a generally accepted form of the iron-zinc equilibrium diagram, although a more recent diagram has been presented (15), (16) in which an additional zeta phase has been proposed.

✦ ✦ ✦

THE use of the terms, $FeZn_7$ and Fe_3Zn_{10}, to designate constituent alloy layers is not warranted on the basis of the facts already known. Investigation of the equilibrium diagram, indicates the field designated as $FeZn_7$ to extend in composition of approximately 7 to 11 per cent in iron, and that of Fe_3Zn_{10} to range from 20 to 27 per cent iron. This range in composition should dispel any preconceived notion concerning the existence of true compounds and suggest the use of the more appropriate terms of phases. In fact it is logical to assume that these phases are indeed solid solutions of a special type. These solid solutions, sometimes referred to as secondary solid solutions, are intermediate phases of lattice structure unlike either of the participating metals, but which is definitely that of a compound falling within the range of the solid solution. In other words we have compounds of variable composition which merely implies the existence of a solid solution having properties resembling those of a compound. Therefore it would be more appropriate to refer to $FeZn_7$ and Fe_3Zn_{10} as phases rather than as true compounds in the strictest sense of the term.

✦ ✦ ✦

IN so far as galvanized coatings themselves are concerned they probably can be classified as either of one of two types; bright, shiny, with or without a spangle, or the gray type of coating.

✦ ✦ ✦

Table XXXVIII
Series A

Base Composition: (Sample 10)		C .06	P .019	S .026	Mn .42	Cu .233	Si .106
Coating Microstructure							
Sample	**Analysis**	**30 seconds**		**60 seconds**		**180 seconds**	
10	.233% Cu	Iron-zinc alloy		Iron-zinc alloy		Iron-zinc alloy	
1	.356% Cu	" " "		" " "		" " "	
2	.626% Cu	" " "		" " "		" " "	
10	.106% Si	Iron-zinc alloy		Iron-zinc alloy		Iron-zinc alloy	
3	.220% Si	" " "		" " "		Very thin pure zinc layer over alloy layers	
4	.348% Si	" " "		" " "		Iron-zinc alloy	
5	.610% Si	" " "		" " "		" " "	
10	.42 % Si	Iron-zinc alloy		Iron-zinc alloy		Iron-zinc alloy	
6	.60 % Si	" " "		" " "		" " "	
7	.84 % Si	" " "		" " "		" " "	
10	.019% P	Iron-zinc alloy		Iron-zinc alloy		Iron-zinc alloy	
8	.042% P	" " "		" " "		" " "	
9	.086% P	" " "		" " "		Pure zinc layer, over alloy layers	

COATINGS which appear bright and shiny invariably have a layer of relatively pure zinc over the alloy layers. This outer layer of pure zinc need not be of any considerable thickness to impart a bright, shiny appearance. As a matter of fact, in all of the samples examined, the pure zinc layer, when present, represented but a small fraction of the total thickness of the coating.

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THE gray type of galvanized coating invariably consisted of iron-zinc alloy layers with no pure zinc layer discernible. In most cases, two alloy layers were clearly distinguishable, a narrow layer next to the steel base, and a relatively wider or thicker layer on the outside. It is obvious that the iron-zinc phases closest to the steel base are highest in iron content so that the principal constituents would be the Fe_3Zn_{10} phase with varying amounts of the $FeZn_7$ phase depending upon the iron content. It is likely that the inner alloy layer is comprised chiefly of the Fe_3Zn_{10} phase with a transition zone of the Fe_3Zn_{10} and $FeZn_7$ phases and an outer zone of the $FeZn_7$ phase. It would seem much more convenient to refer to these various constituents as specifically designated phases as suggested by **Schromm (16).** In galvanized coatings true equilibrium conditions do not exist since rates of cooling are rapid and there always exists a concentration gradient between the outside of the coating and the steel base depending upon the thickness and rates of diffusion. For this reason, then, hot-dip galvanized coatings are very complex in nature, and do not readily lend themselves to a precise interpretation.

✦ ✦ ✦

THE fact that certain steels galvanize with bright, shiny light-weight coatings which show an outer layer of pure zinc, whereas other steels galvanized under identical conditions produce gray, heavy coatings comprised entirely of iron-zinc alloy layers, indicates fundamental differences in the rate of alloy formation between the iron and zinc. In cases where ex-

tremely heavy coatings are produced, the alloying action between the iron and zinc is certainly more rapid, and is obviously a function of the composition of the steel base since that is the only variable involved.

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The Mechanism of Coating Formation

THE mechanism of formation of a hot-dip galvanized coating is relatively simple and normally consists of: (1) Reaction between the steel base in the bath to form iron-zinc alloys of varying composition. It is probable that the iron diffuses outward to form high-melting point compounds or phases, part of which remain attached to the steel base and form the basis for further growth. Part of these iron-zinc compounds sink to the bottom of the spelter pan to form what is commonly known as dross.

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THE increase in thickness of the alloy layer continues as long as the steel remains in the spelter. The greater the diffusibility of the iron, the greater will be the thickness of the alloy layer. The diffusibility of the iron seems to be affected by other elements in solid solution in the iron. In other words, the "solution pressure" of various steels in spelter is influenced by the base composition.

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AS the steel is removed from the spelter it is covered or 'wetted' by molten pure zinc in a purely incidental manner. This molten zinc will eventually freeze as such unless there is sufficient sensible heat left in the steel to prolong the alloying action, in which case the surface layer of pure zinc will be entirely used up to form iron-zinc alloys. This phenomenon is readily observed to take place after the specimens have been removed from the spelter. All of the samples are alike in that they are all coated with a layer of bright, shiny molten zinc; after a relatively short time however the change from a bright, shiny appearance to a gray takes place in plain view over a period of time of possibly ten seconds or more. In other cases, the bright

Table XXXIX
Series B

Base Composition:		C	P	S	Mn	Cu	Si
(Sample 10)		.17	.019	.032	.48	.235	.015

Coating Microstructure

Sample	Analysis	30 seconds	60 seconds	180 seconds
10	.235% Cu	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers
1	.388% Cu	"	"	"
2	.676% Cu	"	"	"
10	.015% Si	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers
3	.132% Si	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
4	.249% Si	" " "	" " "	" " "
5	.508% Si	" " "	" " "	" " "
10	.48 % Mn	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers
6	.73 % Mn	"	"	"
7	.85 % Mn	"	"	"
10	.019% P	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers
8	.045% P	Iron-zinc alloy	Iron-zinc alloy	Extremely thin non-continuous layer of pure zinc over rough surface
9	.084% P	" " "	" " "	"

Table XL
Series C

Base Composition:		C	P	S	Mn	Cu	Si
(Sample 10)		.32	.017	.027	.50	.191	.127

Coating Microstructure

Sample	Analysis	30 seconds	60 seconds	180 seconds
10	.191% Cu	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
1	.358% Cu	" " "	" " "	" " "
2	.600% Cu	" " "	" " "	" " "
10	.127% Si	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
3	.248% Si	" " "	" " "	" " "
4	.357% Si	" " "	" " "	" " "
5	.625% Si	" " "	" " "	" " "
10	.50 % Mn	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
6	.69 % Mn	" " "	" " "	" " "
7	.89 % Mn	" " "	" " "	" " "
10	.017% P	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
8	.040% P	" " "	" " "	" " "
9	.080% P	" " "	" " "	" " "

Table XLIII
Series G

Base Composition:		C	P	S	Mn	Cu	Si
		.10	.099	.035	.39	.292	.218

Coating Microstructure

Sample	Analysis	30 seconds	60 seconds	180 seconds
P-1	.218% Si	Iron-zinc alloy	Iron-zinc alloy	Extremely thin pure zinc layer over alloy layers.
P-2	.500% Si	" " "	" " "	Iron-zinc alloy

Table XLI
Series E

Base Composition:	C	P	S	Mn	Cu	Si
(Sample 12)	.11	.015	.028	.42	.175	.0090

Coating Microstructure

Sample	30 seconds	60 seconds	180 seconds
12	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers
1	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
2	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers
3	"	"	"
4	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
5	" " "	" " "	" " "
6	" " "	" " "	" " "
7	" " "	" " "	" " "
8	" " "	" " "	Extremely thin pure zinc layer over alloy layers - barely discernible
9	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
10	" " "	" " "	" " "
11	" " "	" " "	" " "

Table XLII
Series F

Base Composition:		C	P	S	Mn	Cu	Si
(Sample 8)		.05	.011	.026	.45	.229	.120

Coating Microstructure

Sample	Analysis	30 seconds	60 seconds	180 seconds
8	.05 % C	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
1	.20 % C	" " "	" " "	" " "
2	.35 % C	" " "	" " "	" " "
8	.000% Ti	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
3	.042% Ti	" " "	" " "	" " "
4	.100% Ti	" " "	" " "	" " "
5	.169% Ti	" " "	" " "	" " "
8	Trace Al	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy
6	.145% Al	" " "	" " "	" " "
7	.303% Al	" " "	" " "	Extremely thin pure zinc layer over alloy layers

Table XLIV
Series H

Individual Heats

Coating Microstructure

Sample	30 seconds	60 seconds	180 seconds
B-1	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers
B-2	Iron-zinc alloy	Iron-zinc alloy	Extremely thin pure zinc layer over alloy layers
B-3	" " "		"
B-4	" " "	" " "	Iron-zinc alloy
B-5	" " "	" " "	Extremely thin pure zinc layer over alloy layers
		" " "	
R-1	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers	Pure zinc layer over alloy layers
R-2	"	"	"
S-1	Iron-zinc alloy	Iron-zinc alloy	Iron-zinc alloy

shiny molten zinc freezes to form a bright, shiny and sometimes spangled surface.

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RAPID cooling by means of fans or a water quench freezes the pure zinc layer and cools the object as a whole so that further diffusion and alloying is stopped-immediately in the case of the water quench.

✦ ✦ ✦

LARGE objects with relatively small surface area and galvanized at short immersion times will be more likely to produce gray coatings than thin sections like sheet, strip or bands which lose their heat much more rapidly. On the other hand objects left in the spelter for long periods of time form, in some cases, extremely heavy alloy coatings, so heavy in fact that the rate of diffusion of iron into the zinc layer is materially reduced. In fact so much so that after cooling there still remains a sufficiently thick layer of pure zinc to produce a bright, shiny coating. It was an interesting fact that the samples which galvanized bright at the three minute immersion either had very heavy coatings or had the lightest coating values in any particular set, as for example, sample 3 and 9 in Series A, the low points in the silicon and phosphorus curves respectively (3 minute immersion). On the other hand in Series B, samples 4 and 9 represent the low and high points in the silicon and phosphorus curves respectively, sample 4 was 60 per cent bright and sample 9 was 100 per cent bright.

✦ ✦ ✦

IN the one case a bright coat results from a retarded alloying action due to the peculiarities of the base composition, in which case the pure zinc layer is not materially reduced in thickness by continued alloying action and a bright coat remains. On the other hand a bright coat results from the sluggishness of the alloying action having to proceed at slower rates due to a relatively low iron content at the outer surface of a very thick alloy coating. The lower concentration gradient reduces the rate of diffusion of iron into the zinc coating and as a result this layer

PHOTOMICROGRAPHS

Series A

EFFECT OF COPPER ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
(Sample 10)	.06	.019	.026	.42	.233	.106

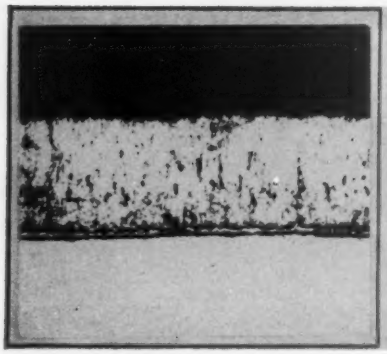

Fig. 82. Sample 10, .233% Cu, 60 second immersion. X250.

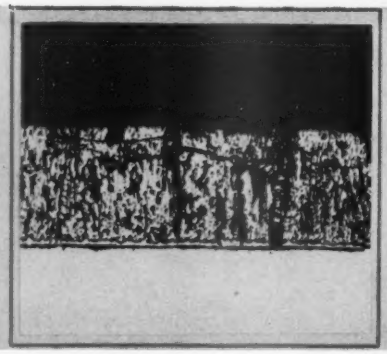

Fig. 83. Sample 1, .356% Cu, 60 second immersion. X250.

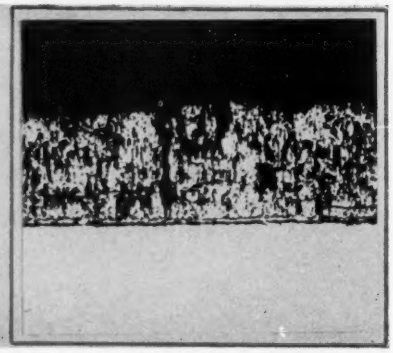

Fig. 84. Sample 2, .626% Cu, 60 second immersion. X250.

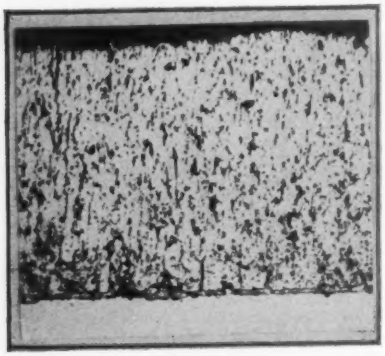

Fig. 85. Sample 10, .233% Cu, 180 second immersion. X250.

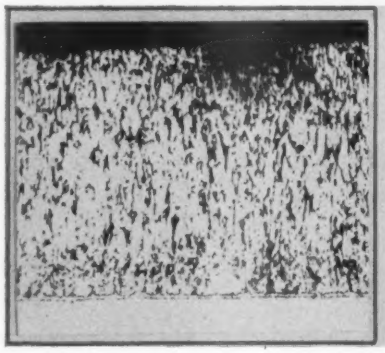

Fig. 86. Sample 1, .356% Cu, 180 second immersion. X250.

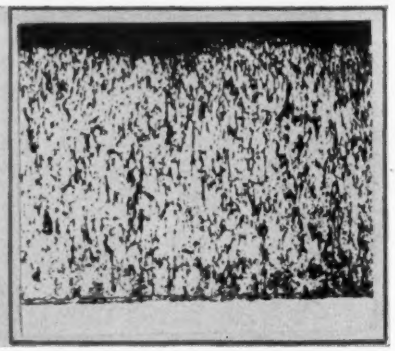

Fig. 87. Sample 2, .626% Cu, 180 second immersion. X250.

freezes before it can become entirely alloyed.

✦ ✦ ✦

IN Tables, XXXVIII to XLIV inclusive, a summary is given of the microstructures obtained with each series of samples for each of the three immersion times. It should be remembered that only the top portion (¾" off the top) of the galvanized samples were mounted and that in many cases, at least where the samples were partly bright and partly gray, the metallographic sample always illustrated the gray structure since the gray portions were always the top portions. This is due of course to drainage of the zinc down the sides of the sample, and because of this, the coatings were always slightly heavier at the bottom portion. To maintain consistency in order to obtain comparable results, all of the metallographic specimens were obtained from the same relative position in the sample.

✦ ✦ ✦

Discussion of Coating Microstructures Series A

TABLE XXXVIII summarizes the general types of microstructures obtained. In all cases, with the exception of samples 3 and 8 at the three minute immersion, the coating structures were comprised of iron-zinc alloys.

✦ ✦ ✦

THE microstructures differed considerably among themselves however. The base composition showed a microstructure consisting of a very thin alloy layer showing a relatively fine matrix. The inner alloy layer was of uniform thickness and the line of demarcation was clear and concise. With increased immersion time, the total thickness of the coatings increased although the thickness of the inner alloy layer remained about the same, the growth being confined to the outer layer. With increased immersion time all samples showed a tendency toward the formation of a columnar type of structure.

✦ ✦ ✦

THE copper and manganese steels showed microstructures identical with those exhibited by the base sample, hence it may be safely concluded that neither of these elements noticeably affects the microstructure of a galvanized coating.

✦ ✦ ✦

AS noted previously in observations regarding appearance, adherence and coating weights, neither copper nor manganese exerted any noticeable affect upon these coating properties, hence it

PHOTOMICROGRAPHS
Series A

EFFECT OF SILICON ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
	.06	.019	.026	.42	.233	.106

Fig. 88. Sample 10, 0.016% Si, 60 second. X250. ✦ ✦

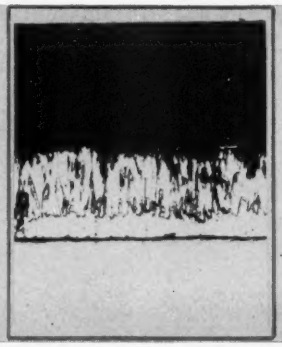

Fig. 89. Sample 3, 0.220% Si, 60 second. X250. ✦ ✦

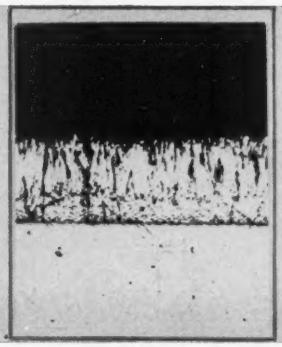

Fig. 90. Sample 4, 0.348% Si, 60 second. X250. ✦ ✦

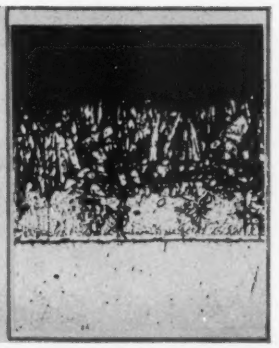

Fig. 91. Sample 5, 0.610% Si, 60 second. X250. ✦ ✦

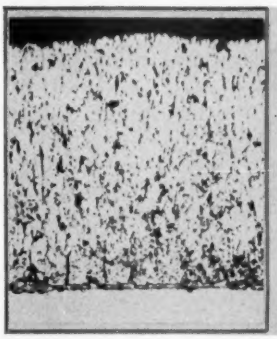

Fig. 92. Sample 10, 0.106% Si, 180 second immersion. X250. ✦

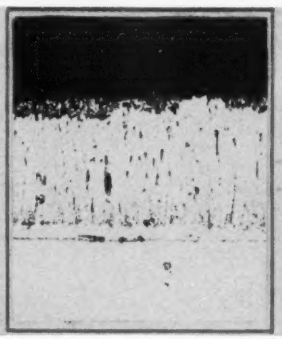

Fig. 93. Sample 3, 0.220% Si, 180 second immersion. X250. ✦

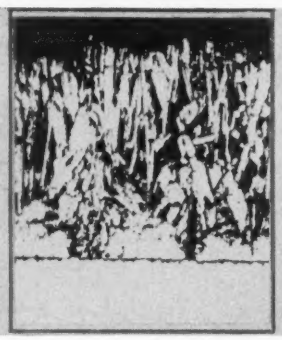

Fig. 94. Sample 4, 0.348% Si, 180 second immersion. X250. ✦

Fig. 95. Sample 5, 0.610% Si, 180 second immersion. X250. ✦

seems reasonable to suppose that their microstructures would not differ from that of the base sample. This supposition is substantiated by observations made in this and subsequent series.

✦ ✦ ✦

THE effect of the silicon additions brought about marked changes in the microstructure. For samples 3 and 4 the thickness of the inner-alloy layer was notably increased. Furthermore the structure observed in the outer-alloy layer was very much coarser and exhibited a decided columnar type of structure. The increase in inner-alloy thickness is most pronounced in the case of sample 3 in which case the thickness of the inner-alloy layer was uniform and the line of demarcation was easily distinguished for all immersion times. With sample 4 the line of demarcation was easily distinguished for all immersion times. With sample 4 the line of demarcation between the inner and outer-alloy layers was readily distinguishable at the ½ and 1 minute immersions but quite irregular and much more difficult to identify at the 3 minute immersion. Sample 5, with the highest silicon content, showed no distinction between inner and outer-alloy layers for any of the immersion times. The microstructures were very complex in nature and exhibited a coarse block-like pattern.

✦ ✦ ✦

IT seems significant that sample 3 which had a definite tendency to galvanize bright, particularly at the longer immersion times, and which showed consistently lighter coatings for all immersion times should exhibit a microstructure which differs from the rest of the silicon group. Briefly stated, this difference consists of a definite increase in thickness of the inner-alloy layer accompanied by a decrease in the total thickness of the coating, thereby increasing the proportionate thickness of the inner-alloy layer in relation to the total thickness. Furthermore the line of demarcation between the inner and outer-alloy layers was clean and distinct. In sample 4 this clearness decreased with increased immersion time. Sample 4, however, had less tendency to brighten and had a somewhat heavier coating weight. These relationships are illustrated in Figure 49.

✦ ✦ ✦

IT seems quite probable that all of the attendant properties of sample 4 as distinguished from the rest of the silicon group are related to its microstructure, the increase in the thickness of the inner-alloy layer, denoting a decreased alloying action which is accountable for the lighter coating

PHOTOMICROGRAPHS

Series A

EFFECT OF MANGANESE ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
	.06	.019	.026	.42	.233	.106

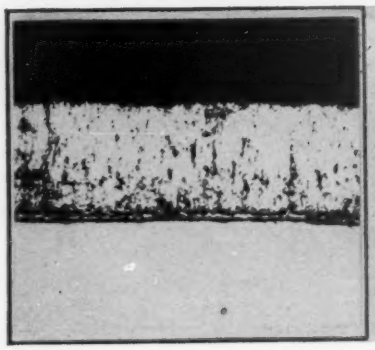

Fig. 96. Sample 10, .42% Mn, 60 second immersion. X250.

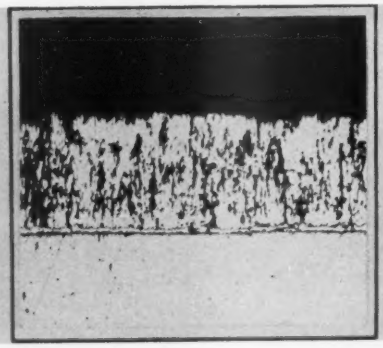

Fig. 97. Sample 6, .60% Mn, 60 second immersion. X250.

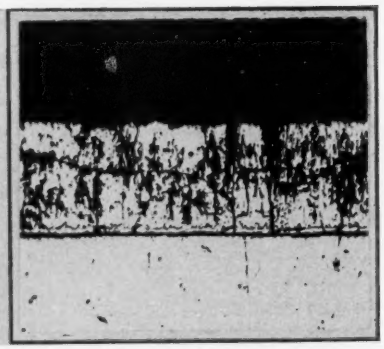

Fig. 98. Sample 7, .84% Mn, 60 second immersion. X250.

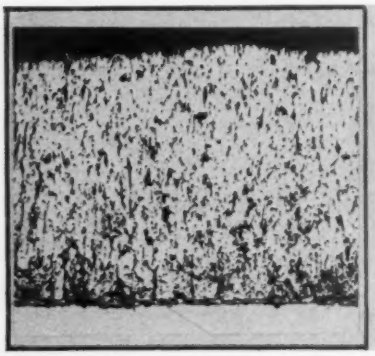

Fig. 99. Sample 10, .42% Mn, 180 second immersion. X250.

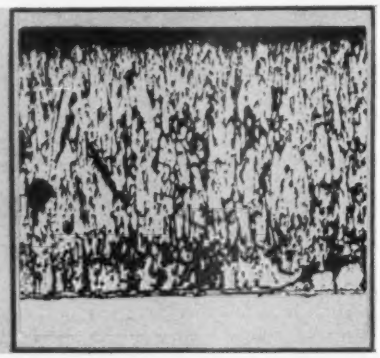

Fig. 100. Sample 6, .60% Mn, 180 second immersion. X250.

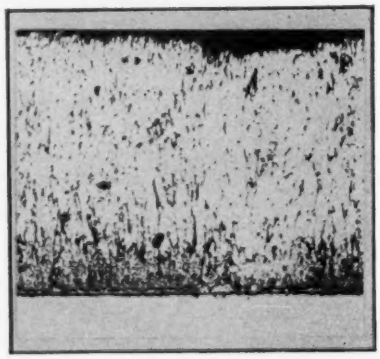

Fig. 101. Sample 7, .84% Mn, 180 second immersion. X250.

weight and its tendency to galvanize with a bright coating.

✦ ✦ ✦

THE effect of increasing the phosphorus content showed a progressive increase in the thickness of the inner-alloy layer, being greatest at 0.086 per cent phosphorus and least at 0.019 per cent. This is very interesting in light of the fact that the coating weights decrease with increased phosphorus content and the tendency to form bright coatings also increased. As mentioned above in connection with the silicon steels, the increased thickness of the inner alloy layer is definitely associated with decreased coating thickness or weight, and the tendency to galvanize with a bright coat.

✦ ✦ ✦

THE structure observed was coarser and had a more definite columnar pattern than the base sample.

✦ ✦ ✦

FIGURES 82 to 107 inclusive show the microstructures for all the samples in this series for the one and three minute immersions.

✦ ✦ ✦

IN regard to the correlation between the microstructures and the results of the bend tests, it is particularly interesting and significant to observe that the poorest inside bend with the silicon steels was obtained with sample 5, the sample which also had the lightest coating weight and the greatest tendency to galvanize bright. This sample had the thickest inner-alloy layer and the least coating thickness in the silicon group, making the ratio of inner-alloy thickness to total coating thickness proportionately greater.

THIS type of structure would resist a compressive stress on the inside bend less effectively than the tensile stresses on the outside bend for the reason that the compressive stress would cause buckling or crushing of the high-iron content, thick inner-alloy layer, thereby causing innumerable fine cracks and flakes which could be easily rubbed off. On an outside bend, the inner-alloy layer would merely crack but would not lift out since no lifting or buckling action would be attendant. This seems to be in accordance with observed facts concerning the increased hardness and brittleness of this inner-alloy layer.

✦ ✦ ✦

SAMPLE 4, which had a thinner and more irregular inner-alloy layer showed: (1) Greater total coating thickness, (2) slightly greater coating weight, (3) de-

PHOTOMICROGRAPHS
Series A

EFFECT OF PHOSPHORUS ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
	.06	.019	.026	.42	.233	.106

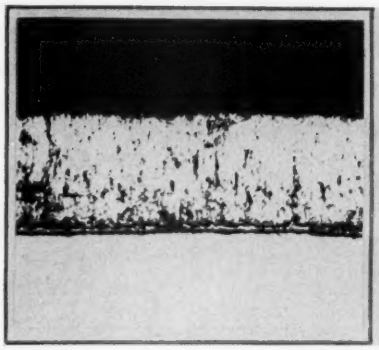

Fig. 102. Sample 10, .019% P, 60 second immersion. X250.

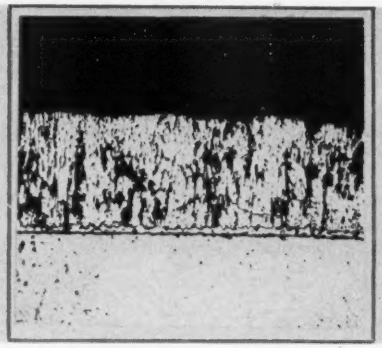

Fig. 103. Sample 8, .042% P, 60 second immersion. X250.

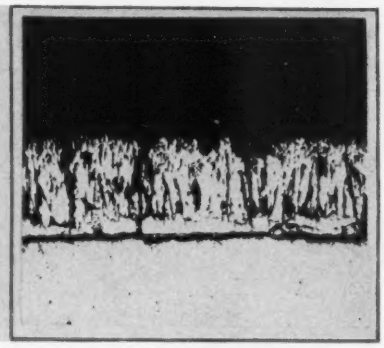

Fig. 104. Sample 9, .086% P, 60 second immersion. X250.

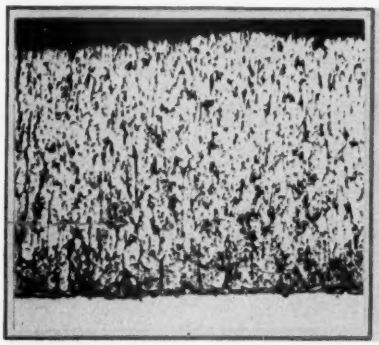

Fig. 105. Sample 10, .019% P, 180 second immersion. X250.

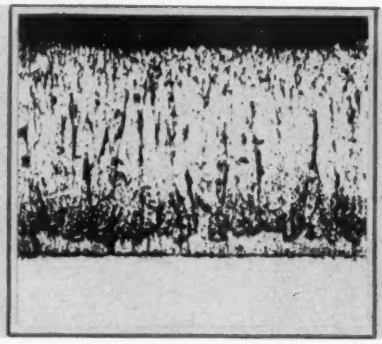

Fig. 106. Sample 8, .042% P, 180 second immersion. X250.

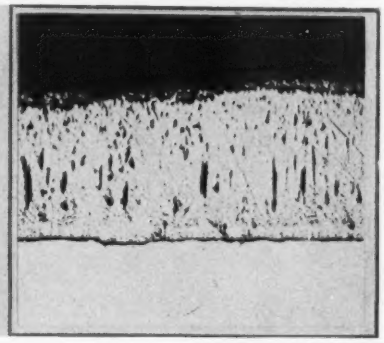

Fig. 107. Sample 9, .086% P, 180 second immersion. X250.

creased tendency to galvanize with a bright coat, and (4) slightly better coating adherence on the inside bend. The latter being the result of a proportionate decrease in inner-alloy layer thickness as well as a proportionate decrease in the ratio of inner-alloy thickness to total thickness, due to the fact that the thickness of the inner-alloy layer decreased whereas the total coating thickness increased.

✦ ✦ ✦

THEREFORE, it seems in the case of Sample 3, we have an exception to the general rule that the best coating thickness is obtained with the least coating thickness. The same is true in the case of the high-phosphorus steels, sample 9, in this series; and for the same reason, namely, an increased inner-alloy layer thickness in connection with a decrease in total coating thickness, the above statement referring to the adherence on the inside bend. It is generally true however, that for a given type of microstructure, thinner coatings have better flexibility and coating adherence. Comparisons of coating adherence between different classes of steels having different types of coatings will not necessarily be in strict accordance with the total coating thickness as indicated above.

✦ ✦ ✦

INCIDENTALLY, sample 9 which had a bright coating for the three minute immersion, showed a microstructure consisting of a very thin pure-zinc layer over the alloy layers. It is the decreased alloying action of the iron in the steel base which retards the changing over of the bright pure-zinc layer to gray alloy layer. When the action is rapid the pure-zinc layer becomes alloyed with iron before it freezes and therefore changes in appearance as well as in microstructure.

✦ ✦ ✦

Series B

FIGURES 108 to 146, inclusive, show the microstructures for all of the samples in this series. Table XXXIX summarizes the general types of coatings obtained. The base sample had a bright, shiny, spangled coating for all immersion times. The pure-zinc layer over the alloy layers can readily be observed.

✦ ✦ ✦

MICROSTRUCTURES identical with those of the base sample were obtained with samples 1, 2, 6 and 7. This would tend to prove, as was already previously indicated in Series A, that neither copper nor manganese affects the microstructures of hot-dip galvanized coatings.

PHOTOMICROGRAPHS

Series B

EFFECT OF COPPER ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
(Sample 10)	.17	.019	.032	.48	.235	.015

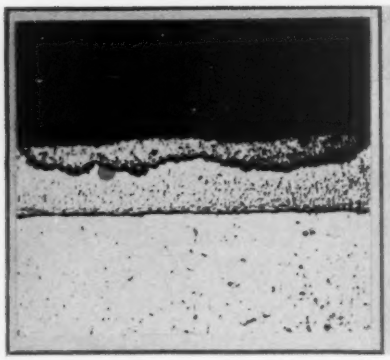

Fig. 108. Sample 10, .235% Cu, 30 second immersion. X250. ✦ ✦ ✦

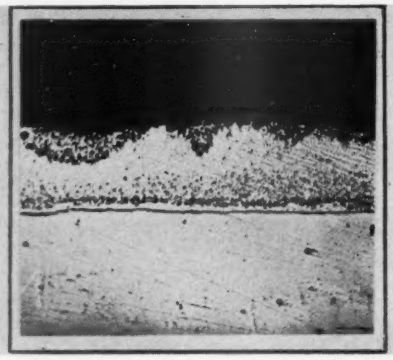

Fig. 109. Sample 1, .388% Cu, 30 second immersion. X250. ✦ ✦ ✦

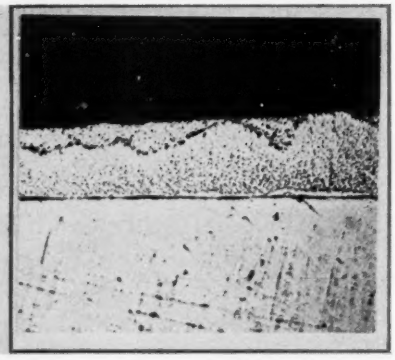

Fig. 110. Sample 2, .676% Cu, 30 second immersion. X250. ✦ ✦ ✦

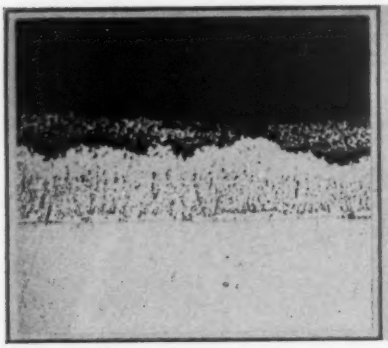

Fig. 111. Sample 10, .235% Cu, 60 second immersion. X250. ✦ ✦ ✦

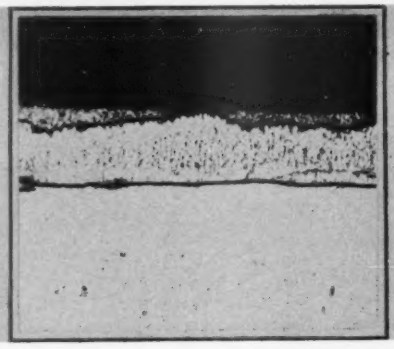

Fig. 112. Sample 1, .388% Cu, 60 second immersion. X250. ✦ ✦ ✦

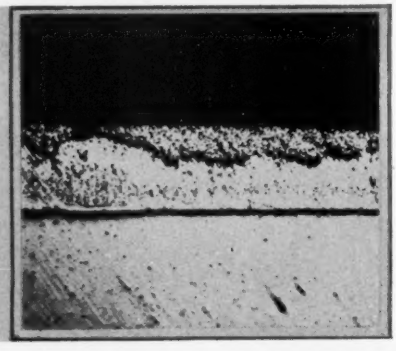

Fig. 113. Sample 2, .676% Cu, 60 second immersion. X250. ✦ ✦ ✦

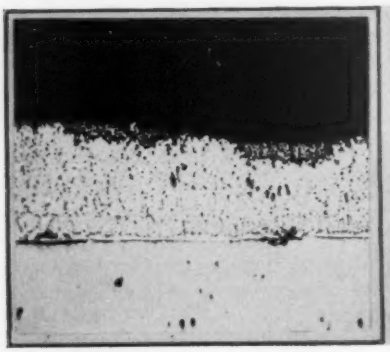

Fig. 114. Sample 10, .245% Cu, 180 second immersion. X250. ✦ ✦ ✦

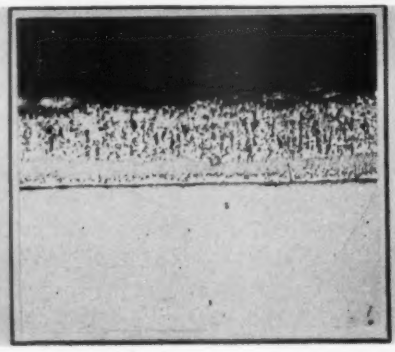

Fig. 115. Sample 1, .388% Cu, 180 second immersion. X250. ✦ ✦ ✦

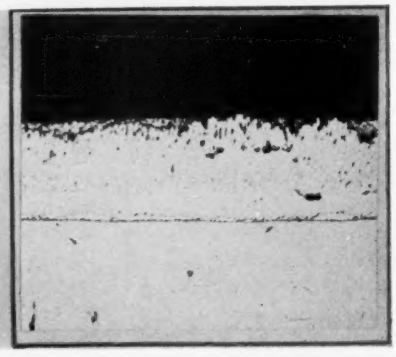

Fig. 116. Sample 2, .676% Cu, 180 second immersion. X250. ✦ ✦ ✦

THE addition of small amounts of silicon to the base composition produced very marked changes in microstructure. Notably absent was the pure-zinc layer. The coatings were composed entirely of iron-zinc alloy layers, hence the outward appearance of these coatings was gray. At the three minute immersion, however, sample 4 had a pronounced tendency toward producing a bright coating, this particular composition, as in Series A, had the lightest coating of the group.

✦ ✦ ✦

THE increase in silicon content caused the disappearance of the pure-zinc layer at all immersion times. The lower 60 per cent of Sample 4 was bright at the three minute immersion, however, since the metallographic specimen was obtained from the top, gray-portion the microstructure did not have present a layer of pure zinc on the outside.

PHOTOMICROGRAPHS
Series B

EFFECT OF SILICON ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
	.17	.019	.032	.48	.235	.015

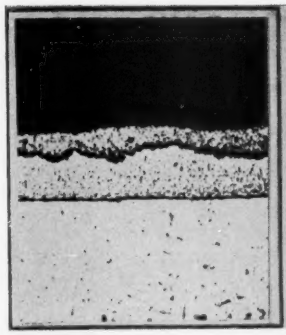

Fig. 117. Sample 10, 0.015% Si, 30 second immersion. X250. ✦

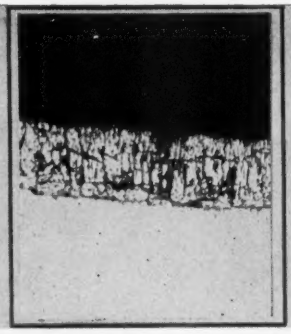

Fig. 118. Sample 3, 0.132% Si, 30 second immersion. X250. ✦

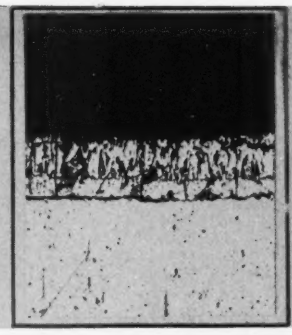

Fig. 119. Sample 4, 0.249% Si, 30 second immersion. X250. ✦

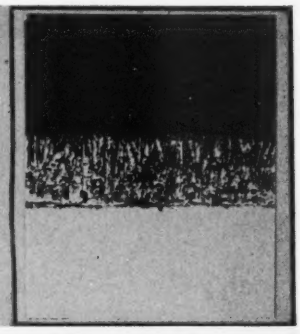

Fig. 120. Sample 5, 0.508% Si, 30 second immersion. X250. ✦

Fig. 121. Sample 10, 0.015% Si, 60 second immersion. X250. ✦

Fig. 122. Sample 3, 0.132% Si, 60 second immersion. X250. ✦

Fig. 123. Sample 4, 0.249% Si, 60 second immersion. X250. ✦

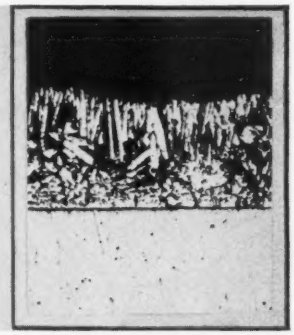

Fig. 124. Sample 5, 0.508% Si, 60 second immersion. X250. ✦

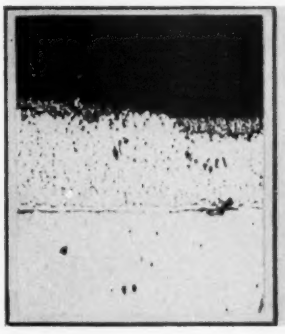

Fig. 125. Sample 10, 0.015% Si, 180 second immersion. X250. ✦

Fig. 126. Sample 3, 0.132% Si, 180 second immersion. X250. ✦

Fig. 127. Sample 4, 0.249% Si, 180 second immersion. X250. ✦

Fig. 128. Sample 5, 0.508% Si, 180 second immersion. X250. ✦

SAMPLE 4 had a structure similar to that observed in Sample 5, Series A; the silicon contents being 0.249 and 0.220 respectively. Again present was a relatively thick inner-alloy layer together with a thinner total coating thickness than either sample 3 or 5. This substantiates the results obtained in Series A, namely, that a silicon steel in the range of .20 to .30 per cent has: (1) Greatest tendency to galvanize with a bright coat at the long immersions, (2) poorest coating adherence on the inside bend, (3) smallest coating weight, (4) smallest coating thickness, and (5) the thickest inner-alloy layer, also the greatest ratio of thickness of inner-alloy layer to total thickness.

✦ ✦ ✦

SAMPLE 3, 0.132 per cent silicon, had a very thin inner-alloy layer at all immersion times, whereas the inner-alloy layer for sample 5, 0.508 per cent, was indistinguishable due to the heterogeneity of the structure as a whole. The discontinuity in this class of steels in the region 0.20 to 0.30 per cent silicon is quite evident.

✦ ✦ ✦

AT the three minute immersion, the coating thickness had in-

PHOTOMICROGRAPHS
Series B

EFFECT OF MANGANESE ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
	.17	.019	.032	.48	.235	.015

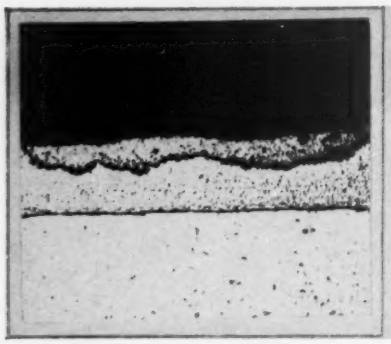

Fig. 129. Sample 10, .48% Mn, 30 second immersion. X250. ✦ ✦ ✦

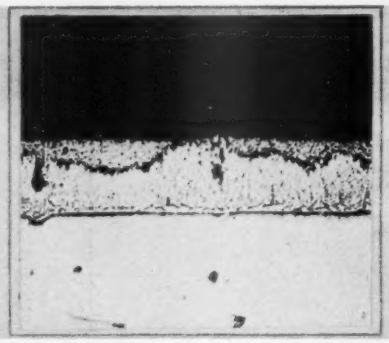

Fig. 130. Sample 6, .73% Mn, 30 second immersion. X250. ✦ ✦ ✦

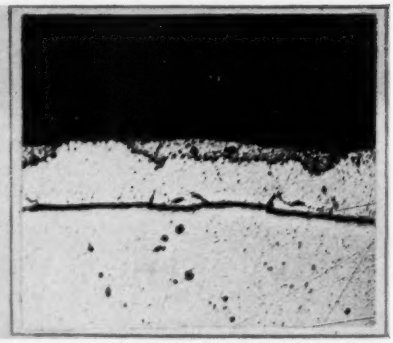

Fig. 131. Sample 7, .85% Mn, 30 second immersion. X250. ✦ ✦ ✦

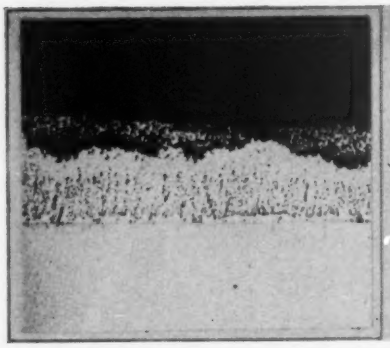

Fig. 132. Sample 10, .48% Mn, 60 second immersion. X250. ✦ ✦ ✦

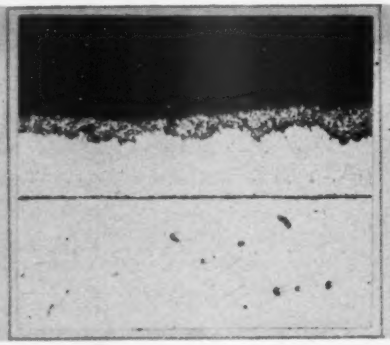

Fig. 133. Sample 6, .73% Mn, 60 second immersion. X250. ✦ ✦ ✦

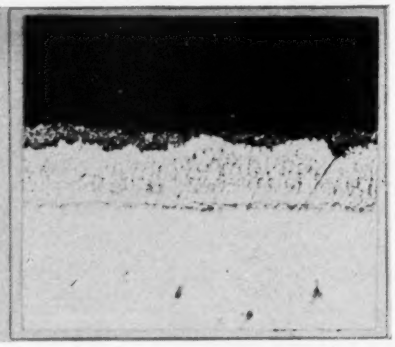

Fig. 134. Sample 7, .85% Mn, 60 second immersion. X250. ✦ ✦ ✦

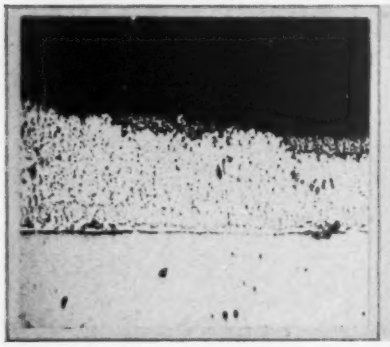

Fig. 135. Sample 10, .48% Mn, 180 second immersion. X250. ✦ ✦ ✦

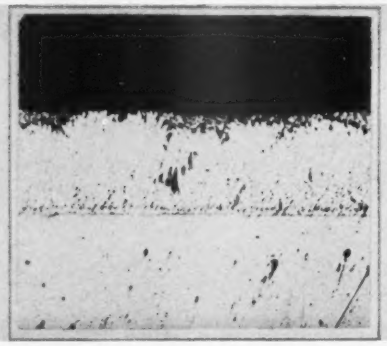

Fig. 136. Sample 6, .73% Mn, 180 second immersion. X250. ✦ ✦ ✦

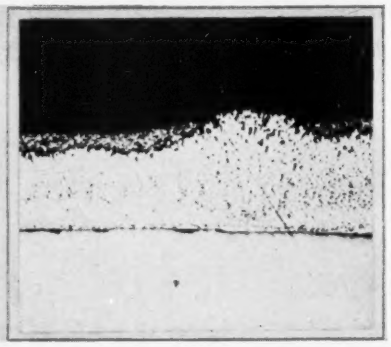

Fig. 137. Sample 7, .85% Mn, 180 second immersion. X250. ✦ ✦ ✦

creased tremendously producing very complex structures. It was quite interesting to observe that the decreased coating thickness of sample 4 corresponded with the actual weight of the coating, the same was true of samples 3 and 5 which had greater coating thickness. As a matter of fact the coating thicknesses showed a very close relationship to the weights of the coatings. The increase in coating thickness with increased immersion time was readily observed.

✦ ✦ ✦

THE effect of increasing the phosphorus content of the base composition was manifested in a very profound manner. Not only did the coating change in appearance from a bright to a gray, but the coating thickness and its microcharacter were notably changed. It appears that phosphorus, unhampered by residual silicon, increases the coating thickness tremendously, the thickness increasing with increased amounts of phosphorus. In most cases the coating was very rough, having a decided tendency toward streaking, that is, forming ridges, along the rolling axis of the specimen.

PHOTOMICROGRAPHS

Series B

EFFECT OF PHOSPHORUS ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
	.17	.019	.032	.48	.235	.015

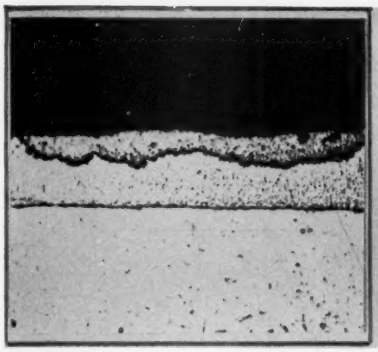

Fig. 138. Sample 10, .019% P, 30 second immersion. X250.

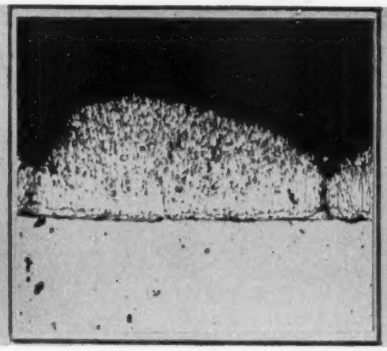

Fig. 139. Sample 8, .045% P, 30 second immersion. X250.

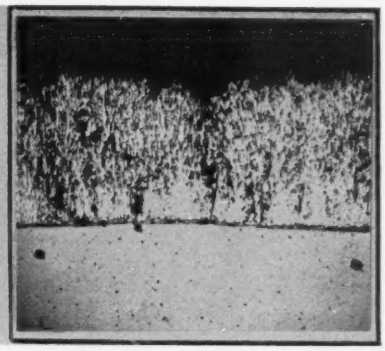

Fig. 140. Sample 9, .084% P, 30 second immersion. X250.

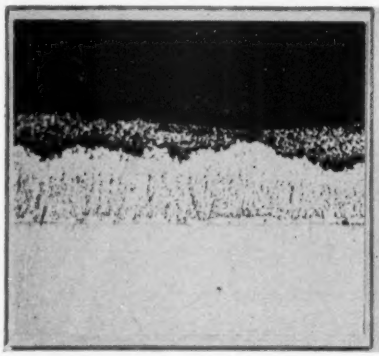

Fig. 141. Sample 10, .019% P, 60 second immersion. X250.

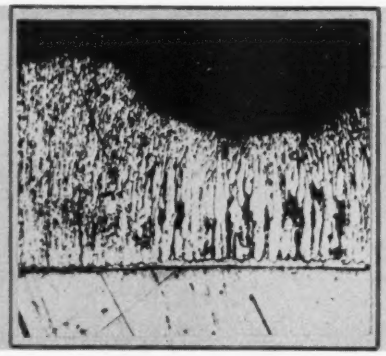

Fig. 142. Sample 8, .045% P, 60 second immersion. X250.

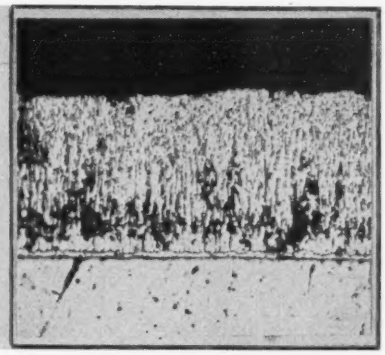

Fig. 143. Sample 9, .084% P, 60 second immersion. X250.

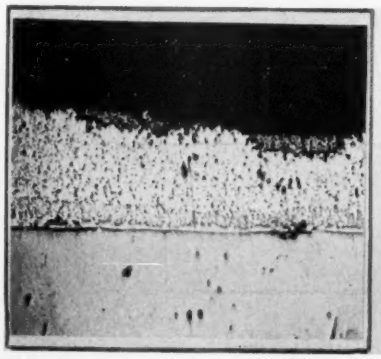

Fig. 144. Sample 10, .019% P, 180 second immersion. X250.

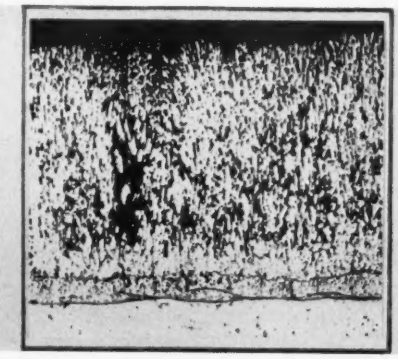

Fig. 145. Sample 8, .045% P, 180 second immersion. X250.

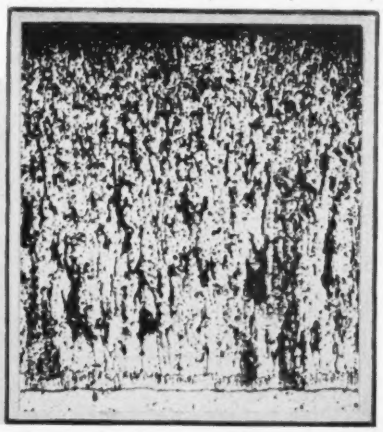

Fig. 146. Sample 9, .084% P, 180 second immersion. X250.

These ridges are so regular as to suggest possible influence by the steel base. This is in no way unlikely since the marked banding effect of phosphorus in ferrite is well known. It is possible that the ridges are the result of an increased alloying effect in contact with a high phosphorus band or striation. At any rate the streaking effects seem to be more noticeable in the lower ranges of phosphorus content. Sample 8, at the thirty and sixty second immersions, showed a portion of its coating with the ridges mentioned above.

✦ ✦ ✦

THE characteristic microstructure appears to have a very thin inner-alloy layer, a matrix

PHOTOMICROGRAPHS
Series C

EFFECT OF SILICON AND PHOSPHORUS ON COATING MICROSTRUCTURE						
Base Composition:	**C**	**P**	**S**	**Mn**	**Cu**	**Si**
(Sample 10)	**.32**	**.017**	**.027**	**.50**	**.191**	**.127**

Fig. 147. Sample 10, 0.127% Si, 180 second immersion. X250. ✦

Fig. 148. Sample 3, 0.248% Si, 180 second immersion. X250. ✦

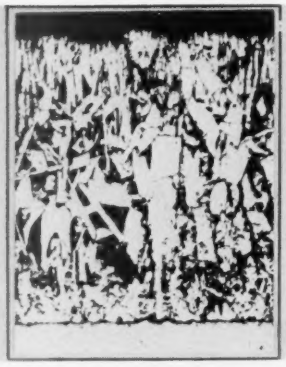

Fig. 149. Sample 4, 0.357% Si, 180 second immersion. X250. ✦

Fig. 150. Sample 5, 0.625% Si, 180 second immersion. X250. ✦

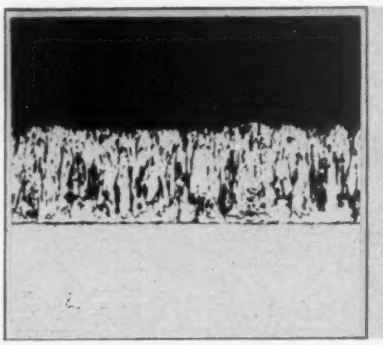

Fig. 151. Sample 10, .017% P, 60 second immersion. X250. ✦ ✦ ✦

Fig. 152. Sample 8, .040% P, 60 second immersion. X250. ✦ ✦ ✦

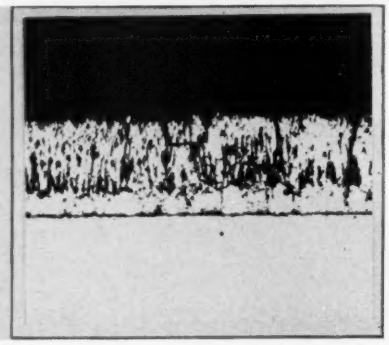

Fig. 153. Sample 9, .080% P, 60 second immersion. X250. ✦ ✦ ✦

not as coarse as the silicon steels, but which appears to have a decided tendency toward a columnar type of structure in the outer-alloy layer. In this respect the two classes of steels are similar except that the columnar crystals in the high-phosphorus steels are longer and more needle-like.

✦ ✦ ✦

IT is quite possible that the flexibility, or the lack of it, is related to this type of structure. It would appear that the flexibility in tension would be nil since the columnar or needle-like structure could be likened to opening a book or deck of cards, the leaves of which extend practically to the steel base. This probably also explains why these same high-phosphorus steels fail to crack or flake on the inside bend, this type of structure being well adapted to absorb compressive stresses. As a matter of fact, where a flake or two would fall off, the piece was unusually large and retained a permanent set in curvature. The remainder of the inside would not show a single crack.

✦ ✦ ✦

THE fact that all the high-silicon steels showed excellent outside bends and good inside bends, except in the range 0.20 to 0.30 per cent, seems to be definitely associated with its coating microstructure. The increased thickness of the inner-alloy layer, so long as it does not approach the critical value in the range of 0.20 to 0.30 per cent silicon, together with a more interlocked crystalline structure in the outer-alloy layer, would tend to increase flexibility both in compression and tension, particularly the latter.

THE presence of residual silicon so greatly influences the effect of phosphorus that only in Series B, D, and E can the phosphorus steels be considered strictly as such. In Series A, and C the residual silicon is high enough to place these steels in the classification of phosphorus-silicon steels, at least in so far as galvanizing is concerned.

✦ ✦ ✦

INCREASED amounts of silicon tend to counteract the effects of phosphorus, so that, if the phosphorus content is relatively low or the silicon content is very high, the predominating characteristics are those of a silicon steel. This manifestation has been previously noted in the effects upon appearance, adherence, coating weights and finally microstructure.

PHOTOMICROGRAPHS
Series E

EFFECTS OF HIGH-PHOSPHORUS, HIGH-SILICON ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
	.11	.015	.028	.42	.175	.0090

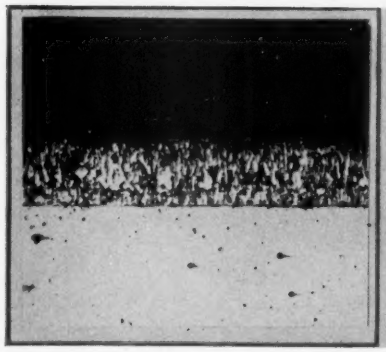

Fig. 154. Sample 9, .080% P, .568% Si, 30 second immersion. X250.

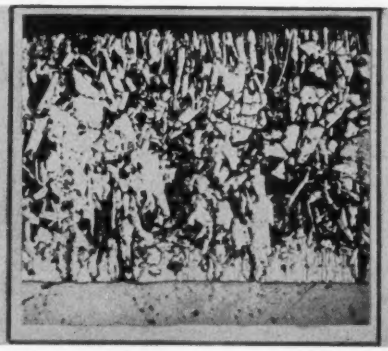

Fig. 155. Sample 9, .080% P, .568% Si, 180 second immersion. X250.

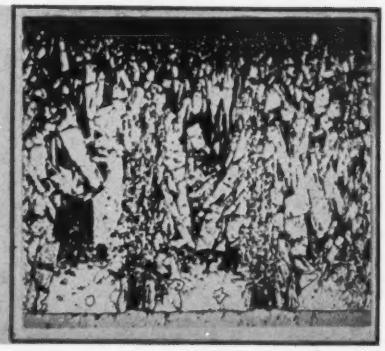

Fig. 156. Sample 7, .086% P, .570% Si, 180 second immersion. X250.

PHOTOMICROGRAPHS
Series F

EFFECTS OF CARBON ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
	.05	.011	.026	.45	.229	.120

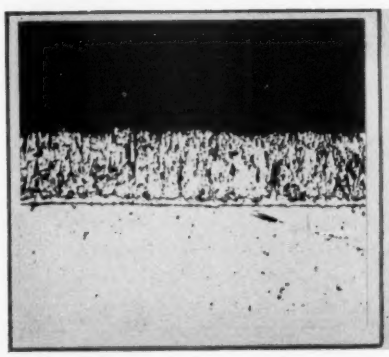

Fig. 157. Sample 8, .05% C, 30 second immersion. X250.

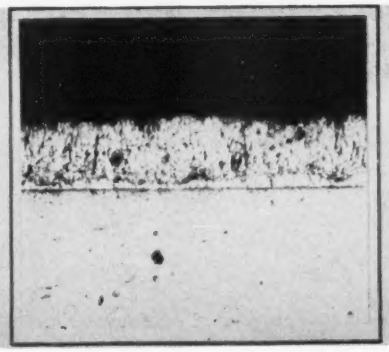

Fig. 158. Sample 1, .20% C, 30 second immersion. X250.

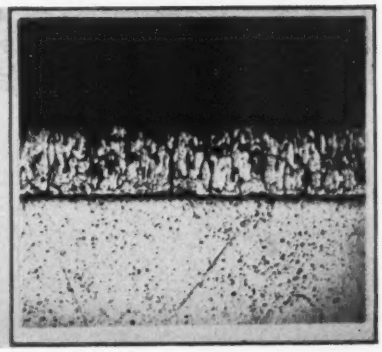

Fig. 159. Sample 2, .35% C, 30 second immersion. X250.

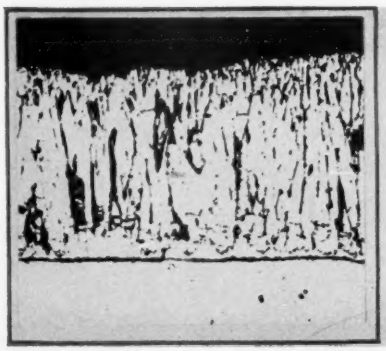

Fig. 160. Sample 8, .05% C, 180 second immersion. X250.

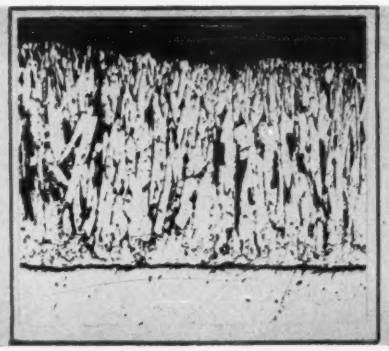

Fig. 161. Sample 1, .20% C, 180 second immersion. X250.

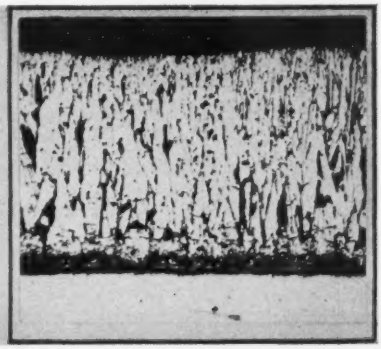

Fig. 162. Sample 2, .35% C, 180 second immersion. X250.

PHOTOMICROGRAPHS
Series F

EFFECT OF TITANIUM ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
(Sample 8)	.05	.011	.026	.45	.229	.120

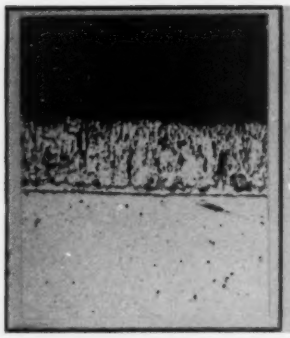

Fig. 163. Sample 8, 0.00% Ti, 30 second immersion. X250. ✦

Fig. 164. Sample 3, 0.042% Ti, 30 second immersion. X250. ✦

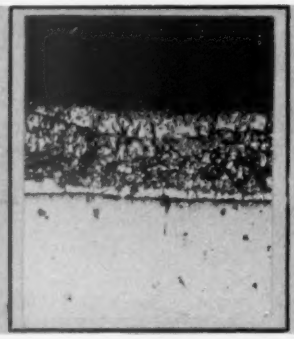

Fig. 165. Sample 4, 0.100% Ti, 30 second immersion. X250. ✦

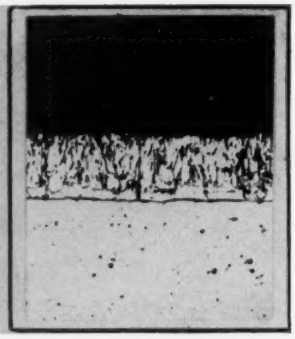

Fig. 166. Sample 5, 0.169% Ti, 30 second immersion. X250. ✦

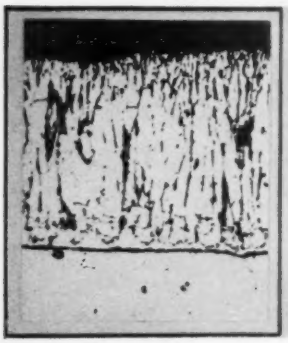

Fig. 167. Sample 8, 0.00% Ti, 180 second immersion. X250. ✦

Fig. 168. Sample 3, 0.042% Ti, 180 second immersion. X250. ✦

Fig. 169. Sample 4, 0.100% Ti, 180 second immersion. X250. ✦

Fig. 170. Sample 5, 0.169% Ti, 180 second immersion. X250. ✦

FOR this reason, then, the coating adherence of the low and medium phosphorus steels in Series A and C is similar to that of the silicon steels, namely, better coating adherence on the outside bend. As the phosphorus content is increased, the effects of phosphorus become more dominant so that the coating adherence is decreased, both on the outside and inside bends. The presence of silicon improves the coating adherence of high phosphorus steels, being most effective when: (1) The phosphorus content is relatively low, or (2) the silicon content is very high.

✦ ✦ ✦

IN Series B, the residual silicon content was so very low that we obtained the true effects of phosphorus alone upon coating adherence, weight and microstructure. The absence of silicon in this series caused even the medium phosphorus sample 8, to have poor coating adherence on the outside bend.

✦ ✦ ✦

Series C

THE base sample had a microstructure consisting of a fairly thin, though irregular inner-alloy layer and an outer-alloy layer with a fine matrix. At the increased immersion time there was a marked tendency toward a columnar type of crystalline structure.

✦ ✦ ✦

AS observed in Series A and B neither copper nor manganese had any effect upon the coating microstructure of the base sample.

✦ ✦ ✦

THE effect of silicon was identical with that observed in Series A and B, namely, that at 0.248 per cent silicon, the microstructure showed a well defined inner-alloy layer and a decrease in the total thickness of the coating. Samples 4 and 5, with 0.357 and 0.625 per cent respectively had microstructures in which the inner-alloy layer could not be distinguished, the structure as a whole being rather coarse and complex. Figures 147 to 150 inclusive show the effect of silicon upon the microstructure of the base sample, note the decreased coating thickness and increased inner-alloy layer thickness of sample 3 as compared with the other steels in this group. Also noteworthy is the absence of the inner-alloy layers and the general complexity of structure in samples 4 and 5. In the base sample the inner-alloy layer is barely distinguishable yet at 0.248 per cent silicon its presence is clear and concise; as the silicon content is increased its presence again diminishes to the vanishing point.

PHOTOMICROGRAPHS
Series F

EFFECT OF ALUMINUM ON COATING MICROSTRUCTURE

Base Composition:	C	P	S	Mn	Cu	Si
	.05	.011	.026	.45	.229	.120

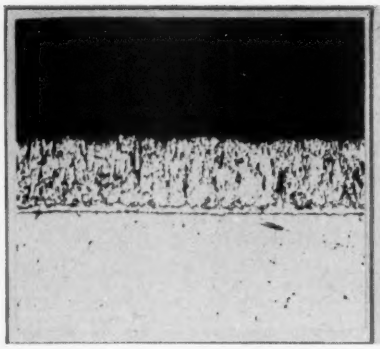

Fig. 171. Sample 8, trace Al, 30 second immersion. X250.

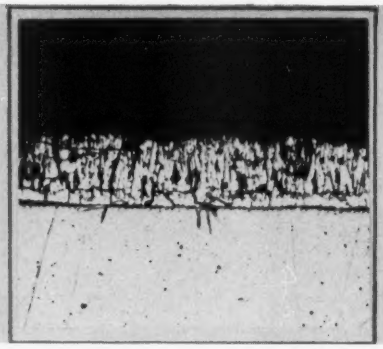

Fig. 172. Sample 6, 145% Al, 30 second immersion. X250.

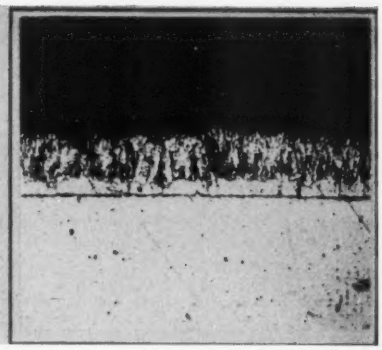

Fig. 173. Sample 7, .303% Al, 30 second immersion. X250.

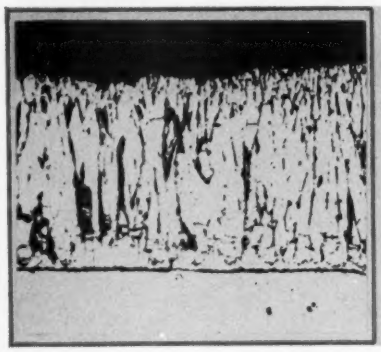

Fig. 174. Sample 8, trace Al, 180 second immersion. X250.

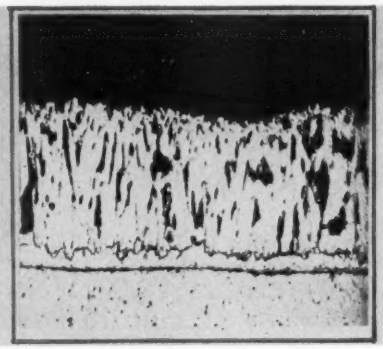

Fig. 175. Sample 6, .145% Al, 180 second immersion. X250.

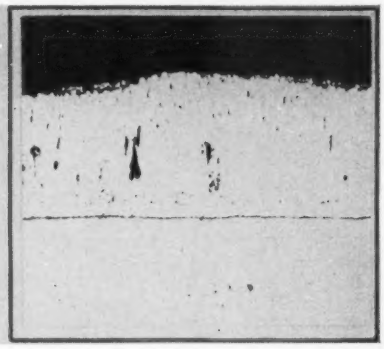

Fig. 176. Sample 7, .303% Al, 180 second immersion. X250.

AT the three minute immersion, sample 5 galvanized completely bright and also had the lightest coating weight. At the thirty-second immersion it showed the poorest coating adherence as observed on the inside bend.

✦ ✦ ✦

THE effect of increasing the phosphorus content of the base sample produced the same results observed in Series A, namely, that with increasing amounts of phosphorus, the coating thickness decreased and the definition and thickness of the inner-alloy layer increased, this is shown in Figures 151 to 153 inclusive. As mentioned previously the presence of increased thickness of the inner-alloy layer always denotes (1) A tendency to form a bright coat at long immersions, (2) poor coating adherence on an inside bend, and (3) lighter coating weights. Sample 9 at the three minute immersion galvanized entirely bright and also showed the lightest coating in the group.

✦ ✦ ✦

THE deductions set forth above apply in all cases to steels containing phosphorus and/or silicon. For straight phosphorus steels containing no appreciable amounts of residual silicon, the extremely high phosphorus steels sometimes galvanized bright at long immersions but for other reasons. In this case the very great thickness of the iron-zinc alloy layer acts in effect as a barrier to furthering the alloying action in the zinc layer, and as a result the pure zinc freezes as such before becoming completely alloyed.

Series E

THE microstructures for the copper, silicon and phosphorus steels in this series were identical with those of corresponding analysis in Series B. Since the base composition was very low in residual silicon, the true effects of increased phosphorus content were again obtained.

✦ ✦ ✦

IN this series, however, were prepared the high phosphorus—high silicon steels, with and without copper. Since the copper content had no effect upon the type of structure obtained it will only be necessary to discuss the aspects of the phosphorus-silicon combination. The silicon content was sufficiently high to impart the predominating effect, the microstructures therefore resembling those

of high-silicon steels of the same silicon content without the phosphorus. Figures 154 and 155 show the coating microstructure of sample 9, 0.080 per cent phosphorus and 0.568 per cent silicon, for ½ and 3 minute immersions. Note the absence of an inner-alloy layer in either case and the resemblance to the high-silicon steels in other series.

✦ ✦ ✦

THIS coincidence is not entirely unexpected since the coatings of these high phosphorus — high silicon steels resemble those of the straight high-silicon steels in all other respects, in regard to appearance, adherence, weight and finally microstructure.

✦ ✦ ✦

Series F

THE effect of increasing the carbon content of the base sample was without noticeable effect upon the microstructure as can be observed by comparison of their photomicrographs. The silicon content appears to be the dominating factor in determining microstructures of these particular steels.

✦ ✦ ✦

THE effect of increasing of titanium content was not particularly outstanding. There was however, a slight increase in the thickness of the inner-alloy layer, with increased titanium content, being especially noticeable for the three minute immersion. This increase in inner-alloy layer, accompanied by a slight decrease in total coating thickness is in accordance with the usual brightening tendency, poorer coating adherence and lighter coating weight.

✦ ✦ ✦

THE effect of increasing the aluminum content of the base composition was very interesting since it was originally thought that the role of this element would be nil. As a matter of fact, however, the increase in aluminum content produced a marked increase in the thickness of the inner-alloy layer, quite easily observed at either the ½ or 3 minute immersion. Furthermore, the total coating thickness decreased. Figures 157 to 176 inclusive, show the microstructures for all of the samples in series at ½ and 3 minute immersions.

PHOTOMICROGRAPHS
Series G

EFFECT OF HIGH-SILICON ON A HIGH-PHOSPHORUS STEEL

Base Composition:	C	P	S	Mn	Cu	Si
(Sample P-1)	.10	.099	.035	.39	.292	.218

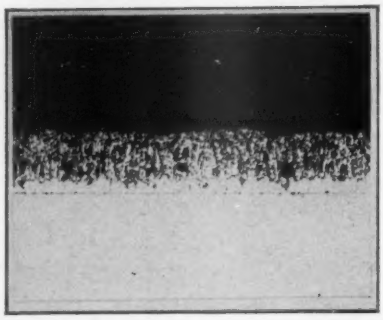

Fig. 177. Sample P-1, .218% Si, 30 second immersion time. X250. ✦ ✦

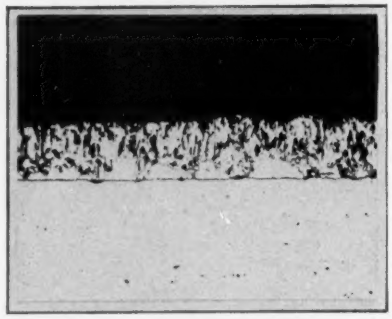

Fig. 178. Sample P-2, .500% Si, 30 second immersion time. X250. ✦ ✦

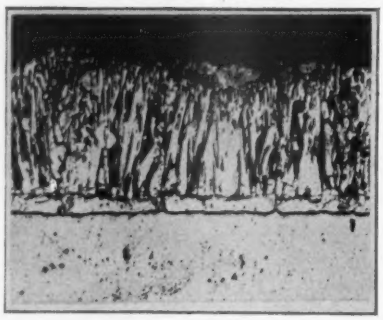

Fig. 179. Sample P-1, .218% Si, 180 second immersion time. X250. ✦ ✦

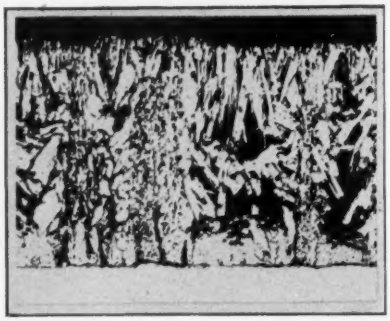

Fig. 180. Sample P-2, .500% Si, 180 second immersion time. X250. ✦ ✦

✦ ✦ ✦

AS might be expected, these high-aluminum samples galvanized bright, 90 and 100 per cent respectively. The poor inside bends exhibited by these samples are characteristic of coatings having thick inner-alloy layers. In this respect this class of steels resembled the silicon steels in the range 0.20 to 0.30 per cent silicon.

✦ ✦ ✦

Series G

THE addition of silicon to a high-phosphorus steel already high in silicon brought about the expected changes in microstructure. The original coating structure of base sample consisted of a fairly thick inner-alloy which could be readily identified. By increasing the silicon content from 0.218 to 0.500 per cent, the microstructure revealed the disappearance of the inner-alloy layer at both the ½ and 3 minute immersions.

✦ ✦ ✦

SAMPLE P-1, 0.218 per cent silicon, showed a strong tendency to galvanize bright, and at the three minute immersion was completely bright. Furthermore, it had the lighter coating of the two, these properties being in accordance with previous results reported in other series and compatible with the type of coating microstructure obtained. Figures 177 to 180 inclusive show the coating microstructures for the samples in this series.

✦ ✦ ✦

Series H

THE microstructures for the steels in this series coincided with those of previous series for a comparable analysis. The importance of being able to check the results on steels from many different heats was very heartening indeed.

PHOTOMICROGRAPHS
Series H

INDIVIDUAL HEATS

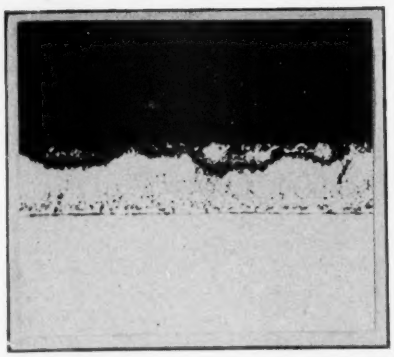

Fig. 181. Sample B-1, .008% Si, .014% P, 30 second immersion. X250.

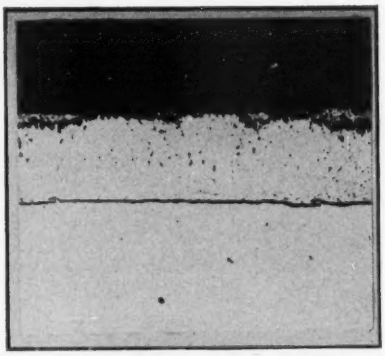

Fig. 182. Sample B-1, .008% Si, .014% P, 180 second immersion. X250.

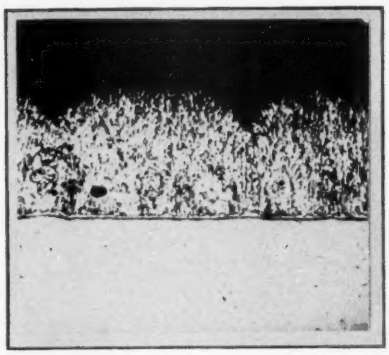

Fig. 183. Sample B-2, .005% Si, .050% P, 30 second immersion. X250.

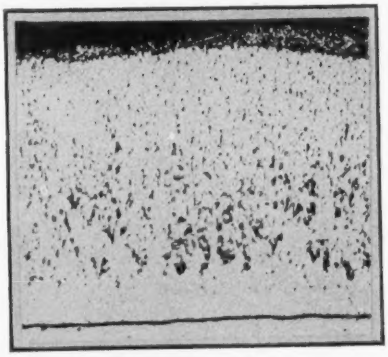

Fig. 184. Sample B-2, .005% Si, .050% P, 180 second immersion. X250.

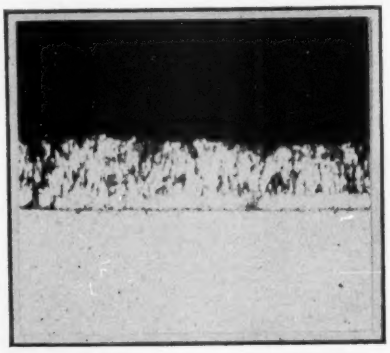

Fig. 185. Sample B-3, .184% Si, .070% P, 30 second immersion. X250.

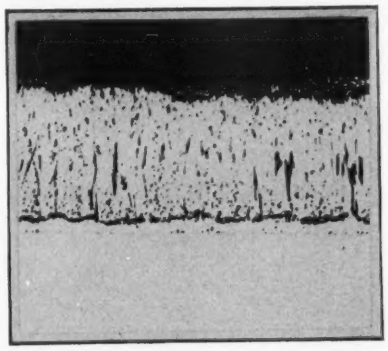

Fig. 186. Sample B-3, .184% Si, .070% P, 180 second immersion. X250.

IN this series we note that the low-silicon, low-phosphorus steel, B-1; and the two rimmed steels, R-1 and R-2, also low in phosphorus and silicon, galvanized with bright, shiny, spangled coatings at all immersion times. The coating microstructure is characteristic for this class of steels, namely, a pure-zinc layer over the alloy layers, the total thickness of the coating being small in comparison with other types of steels, particularly for long immersions. The decreased alloying effect between the steel base and the zinc was outstanding.

✦ ✦ ✦

THE remainder of the steels in this series had coating microstructures identical in nature with those of other series of a comparable analysis and need not be repeated.

✦ ✦ ✦

FIGURES 181 to 192 show the coating microstructures for all of the samples in this series for the ½ and 3 minute immersions.

✦ ✦ ✦

Summary

Properties of Galvanized Coatings vs. Composition of the Steel Base

THIS summary of effects of composition of the steel base upon the various properties of a hot-dip galvanized coating are based upon the conditions of the experimental methods described herein. Under these conditions all of the effects described are reproduceable. However, differences in size and shape of section being galvanized, temperature of spelter, cooling effects, if any; nature of wipes, if any; condition of surface, whether smooth or rough, rate of emergence from spelter, general conditions of pickling and fluxing and possibly other factors, all have a bearing upon the resultant properties of the coating. Assuming, however, that the general effects of most of these factors are known to the average operator in a commercial shop, it is possible, then, to obtain more accurate control over the process as a whole if we know to what extent the steel base affects the type of coating produced. In fact, it should be possible to select steels for galvanizing purposes depending upon the coating characteristics desired.

✦ ✦ ✦

THE following statements summarize the effects of composition of the steel base upon the properties of a hot-dip galvanized coating:

✦ ✦ ✦

I—Effect Upon Appearance

1. **Neither copper nor manganese affects the appearance of the coating.**
2. **Silicon produces a dull gray coating when present in appreciable amounts. This lower limit, above which the effects of silicon is manifested is not known definitely, but is probably in the range of 0.06 to 0.08 per cent.**
   In the range from approximately 0.20 to 0.30 per cent silicon, the steel has a marked tendency to galvanize bright when immersed in spelter for relatively long periods of time, (3 minute). In all other ranges of analysis, the coatings were gray for all immersion times; (½ to 3 minutes).

3. Phosphorus produces a light gray coating when present in fairly large percentages, the critical amount, above which this effect becomes noticeable, is in the range of from 0.030 to 0.040 per cent. This statement is based on the assumption that the residual silicon content is very low, under 0.05 per cent. If the silicon content is up in the range of a silicon-killed steel, the true behavior of phosphorus is not obtained, the coating being gray regardless of the amount of phosphorus present.
4. Silicon-phosphorus steels behave like straight silicon steels and the coatings turn to a dull, dark gray color. Regardless of the phosphorus content, if the silicon is in the range of 0.20 to 0.30 per cent silicon, the tendency to form a bright coating for long immersions is noted.
5. The effect of increased carbon content on a silicon-killed steel is practically without effect. However, with increased carbon content, a slight increase in the tendency to brighten the coating for long immersions is observed.
6. Increased titanium tends to increase the brightening tendency at long immersions.
7. Increased aluminum content had a strong effect in producing bright coatings at long immersions.

✦ ✦ ✦

II—Effect Upon Coating Adherence

1. Neither copper nor manganese had any appreciable effect on coating adherence. It seemed that the presence of copper decreased adherence very slightly but the results were not conclusive.
2. Silicon improves coating adherence on an outside bend. In the range of 0.20 to 0.30 per cent silicon, the coating adherence on the outside bend is greatly decreased.
3. Phosphorus, in the absence of residual silicon, decreases coating adherence tremendously on an outside bend at as low as 0.040 per cent phosphorus. The coating adherence on the inside bends are in most cases perfect without showing even a single crack.
4. Silicon-phosphorus steels, and this classification includes phosphorus steels with residual silicon contents of from 0.10 to 0.20 per cent, have coating adherences which vary according to the amount of each element present. If the silicon content is very high as in Series E, the coating adherence will be good on both the outside and inside bends regardless of the phosphorus content. With decreased amounts of silicon, in the presence of high-phosphorus, the coating adherence drops off rapidly for both the outside and inside bends.
5. The effect of increased amounts of carbon, titanium and aluminum had little, if any effect on the outside bend, however in all cases, the coating adherence on the inside bend was materially decreased.

✦ ✦ ✦

III—Effect Upon Coating Weights

1. Neither copper nor manganese had any appreciable effect upon coating weights.
2. Silicon steels increase coating weight up to about 0.10 per cent, then decrease as the range 0.20 to 0.30 per cent is approached above which the coating weights increase rapidly.
3. Phosphorus, in the absence of residual silicon, increases coating weights tremendously.
4. Silicon-phosphorus combinations behave in two distinct manners: (1) For a given silicon content, increase in phosphorus decreases the coating weight, (2) for a given phosphorus content the silicon behaves in a characteristic manner, the minimum coating values being obtained in the range 0.20 to 0.30 per cent silicon.
5. Carbon had no appreciable effect on coating weights, at least with the range of composition investigated.
6. Increase in titanium decreased the coating weights, particularly for long immersions.
7. Increase in aluminum content brought about a marked decrease in coating weight, most noticeable for long immersion times.

PHOTOMICROGRAPHS
Series H

INDIVIDUAL HEATS

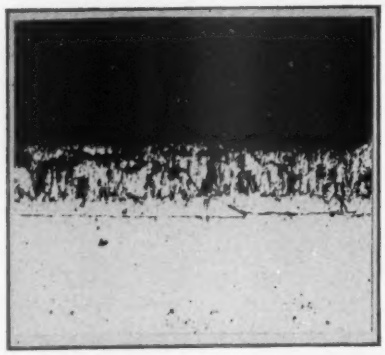

Fig. 187. Sample B-4, .302% Si, .077% P, 30 second immersion. X250. ✦ ✦

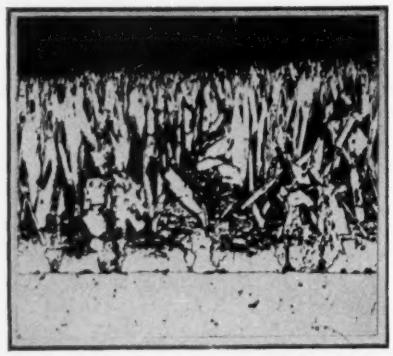

Fig. 188. Sample B-4, .302% Si, .077% P, 180 second immersion. X250. ✦ ✦

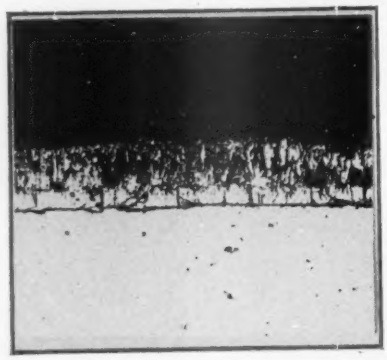

Fig. 189. Sample B-5, .270% Si, .010% P, 30 second immersion. X250. ✦ ✦

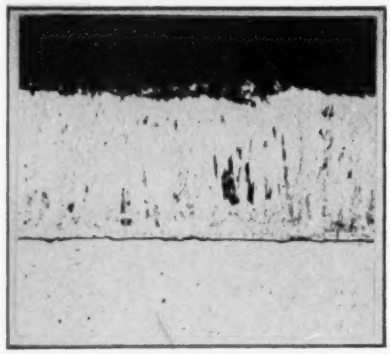

Fig. 190. Sample B-5, .270% Si, .010% P, 180 second immersion. X250. ✦ ✦

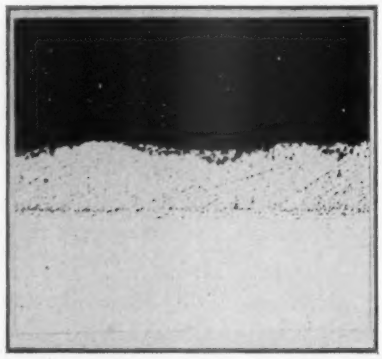

Fig. 191. Sample R-2, .003% Si, .010% P, (Rimmed Steel), 30 second immersion. X250. ✦

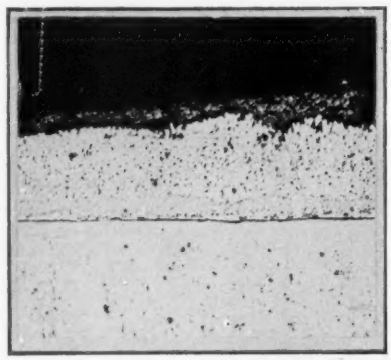

Fig. 192. Sample R-2, .003% Si, .010% P, (Rimmed Steel), 180 second immersion . X250. ✦

IV—Effect Upon Coating Microstructure

1. Neither copper nor manganese had any effect upon the coating microstructures.
2. Increase in silicon content produced coatings consisting of iron-zinc alloys. In the range 0.20 to 0.30 per cent silicon, the inner-alloy layer attained maximum thickness whereas the total coating thickness was at a minimum. At lower silicon values a very thin, sometimes irregular, inner alloy layer was observed. At higher silicon values, no inner-alloy layer could be discerned and the total coating thickness increased rapidly.
3. Increase in phosphorus content in the absence of silicon increased total coating thickness tremendously at the high percentages without noticeably increasing the thickness of the thin inner-alloy layer. The structures were columnar and much finer in detail than the silicon steels.
4. The microstructures for the silicon-phosphorus steels resembled those of the straight silicon steels for the same silicon content, assuming the amount present to be in excess of 0.10 per cent. Increase in phosphorus content increased the thickness and definition of the inner-alloy layer and decreased the total coating thickness.
5. The microstructures for the carbon steels were unaffected by an increase of this element, the structure being determined by the residual silicon content.
6. Increase in titanium content showed a slight though definite increase in the thickness and definition of the inner-alloy layer together with a decrease in total coating thickness.
7. Increase in aluminum content brought about a marked increase in the thickness of the inner-alloy layer and decrease in total coating thickness.
8. In all of the steels where there was a marked increase in the thickness of the inner-alloy layer (always accompanied by a decrease in total coating thickness) there was a very pronounced tendency for these samples to galvanize bright at the long immersion times, the amount ranging from 70 to 100 per cent.

PART I

(Published in November, 1940)
Review of the Literature; Experimental Materials; Experimental Methods; Effect of Composition on Coating Appearances; Effect of Composition on Coating Adherence; Bibliography. ✦ ✦ ✦ ✦ ✦

PART III

(To be published in January, 1941)
Effect of Composition on the Galvanizing of Wire; Effect of Composition on the Galvanizing of Bars. ✦ ✦

Announcing A Special Issue for January, 1941

— SPECIAL BECAUSE —

The discussions on technical papers at the annual meeting of the WIRE ASSOCIATION will be published in their entirety in the regular January issue of WIRE and WIRE PRODUCTS.

✦ ✦ ✦

The Directors of the WIRE ASSOCIATION have approved this plan to provide these discussions to all subscribers without extra cost.

✦ ✦ ✦

— SPECIAL BECAUSE —

THE MORDICA MEMORIAL LECTURE FOR 1940

By Benjamin Lewis McCarthy
Chief Metallurgist,
Wickwire Spencer Steel Company, Buffalo, N. Y.

ON THE SUBJECT

"The Use of Plane Polarized Light and Sensitive Tint Illumination in the Analysis of the Microstructure of Steel"

Will Also Be Published in This Issue.

— SPECIAL BECAUSE —

PART III of the
1940 Wire Association Medal Award Paper
"Galvanizing Characteristics of Different Types of Steel"
By Robert W. Sandelin,
Metallurgist,
Atlantic Steel Co., Atlanta, Ga.
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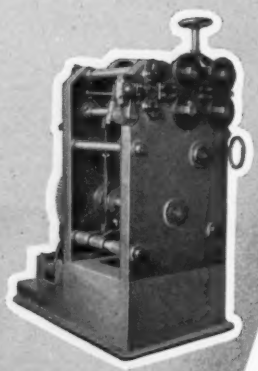

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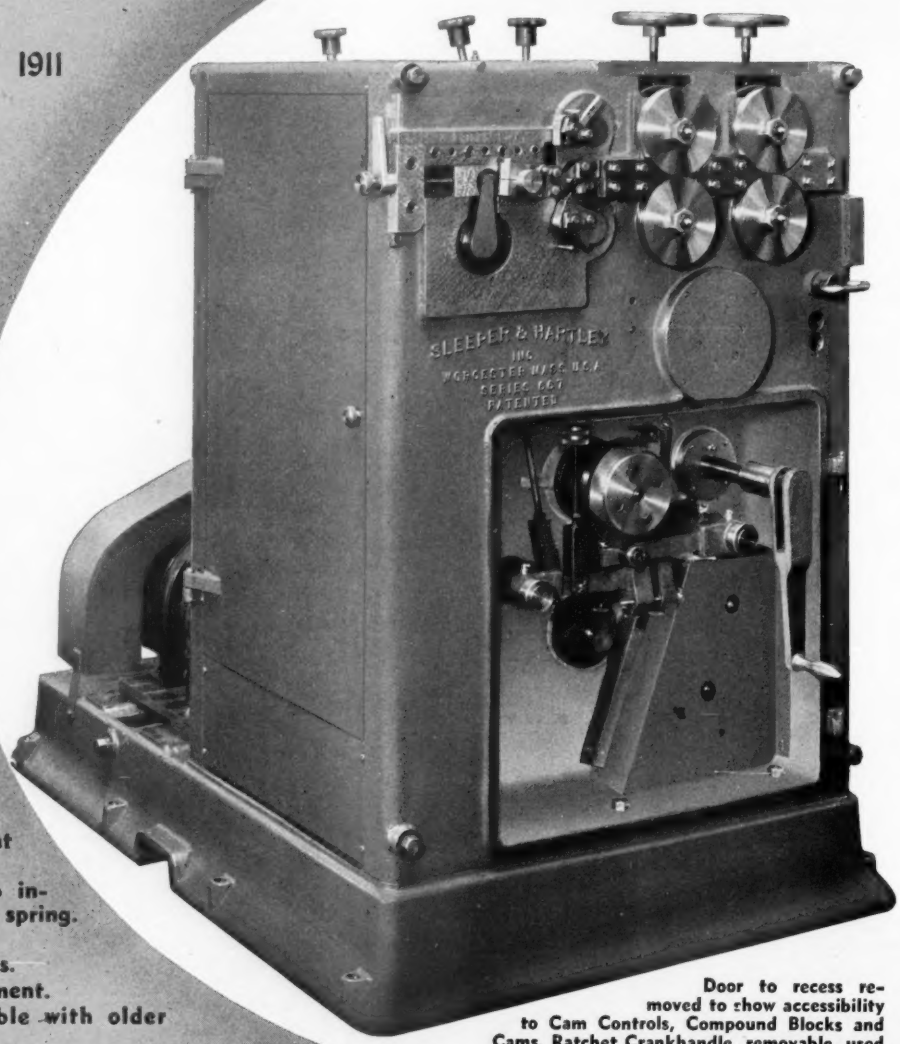

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Recent Development In Heating Copper Wire Bars

By J. A. Doyle,
Vice President,
W. S. Rockwell Company, New York

A PAPER — **"Heating Copper Wire Bars"** — considered at the 1938 meeting of the Wire Association in Detroit, was based on an effort to indicate influence of the several heating processes on quality and uniformity of copper wire in particular and of copper products in general. The purpose of this statement is to supplement the other; to report progress since effected; to indicate that some of the then suggested possibilities are now demonstrated facts; and to encourage thought of still better practice in melting, heating for rolling, and annealing which, all too frequently, are not properly considered as controlling factors in production of better base metal and fabricated products. Products other than wire are referred to because of apparent interest in mills and fabricating shops producing copper products affected by the same factors controlling uniformity in heating and cooling.

✦ ✦ ✦

WEAKNESS of traditional wire bar heating practice in rolling mills (based largely on other traditions) has been conclusively demonstrated in actual daily practice since the discussion at Detroit, through cooperation of producers with courage to support inquiry as to the factual background of the accepted order of things; and not too acutely afflicted with "neophobia"—(or "dread of the new"—as **Dr. E. F. Northrup** so aptly expressed it). As a result, it is apparent that the industry is either now heading in the wrong direction or has been going in the wrong direction for too long a time. The indications are that it is in line for material improvement in heating practice in melting, heating for rolling and annealing that will avoid many difficulties of the past, by the acceptance of a point of view that is new only because a lamentable loss of time was involved in recognition of the obvious, especially when it is so conclusively demonstrated by the test of experience.

This paper may be considered a supplement to a preceding paper published in WIRE & WIRE PRODUCTS, issues of October, 1938 and January, 1939. ✦ ✦ ✦ ✦

Widespread comment on the original justified the editor's statement that it might mark a trend toward a new conception of the influence of heating practice in production of uniform metal. ✦ ✦ ✦ ✦ ✦ ✦

It amplifies the point of view previously recorded and includes further information likely to interest those concerned with production of wire and other copper products. ✦ ✦

✦ ✦ ✦

Recent Practice

WIRE bars are now being produced, commercially, much more uniformly heated, and substantially free of scale in the heating process, at a rate of from 40,000 to 80,000 pounds per hour; and in less time, with less labor, less scrap, faster rolling, and less overall cost.

✦ ✦ ✦

AUTOMATIC control of temperature; of atmosphere; and of pressure of furnace gases are essential factors in producing the result in improved equipment of the pusher type providing for automatic end discharge from two parallel rows of wire bars heated in the same chamber.

✦ ✦ ✦

TEMPERATURE of the individual bar is indicated by a novel arrangement of radiation type pyrometers with provision for an alloy metal "skirt" at the business end of the couple, to avoid radiation effect of flame, particularly when the fire is automatically increased from minimum to maximum. This has been found preferable to the "on and off" cycle of control. Otherwise, as has been found in practice, the chart may indicate variations in temperature that do not actually exist in the bar itself.

✦ ✦ ✦

CO_2 recording is provided to indicate composition of the atmosphere surrounding the bars which, in turn, affords means for controlling the amount of scale. The effectiveness of this provision is indicated by the fact that scale naturally formed on bars during the week-end shut-down is actually reduced in the subsequent heating operation. All told, it demonstrates possibility of control of scale as well as uniformity of the heated bar itself.

✦ ✦ ✦

DECREASE of scale in the heating process, through atmosphere control, has the added advantage of decreasing the tendency of scale to accumulate about the skid rails and react unfavorably in scratching or marking the bars or cakes. The saving of metal in decreased amount of scale, and the influence of scale on the subsequent cost of rolling, drawing, pickling, scrap, etc., is such as

should encourage more thought of the possibility of avoiding scale, and all that goes with it, by methods of heating that will retard it's formation.

✦ ✦ ✦

Fuel Consumption

FUEL consumption is reported as varying from .65 to .8 cubic feet of city gas per pound of metal heated. Similar furnaces operating with oil are stated to require from five to seven gallons per ton of heated metal. Fuel consumption, however, is a delusion and a snare in determining the popular conception of "efficiency" in the operation of such furnaces. As with output per hour, or unit of hearth area, it is both inaccurate and misleading without reference to uniformity of the bar throughout its cross section; and the surface condition of the bar as it enters the rolls. Fuel economy, or increased tonnage as part of an effort to make production records, or to demonstrate "efficiency" of a furnace, is apt to be offset by loss in scrap, and otherwise in the rolling process—unless the bars are properly heated.

✦ ✦ ✦

Pressure in Heating Chamber

PRESSURE of gas is maintained in the heating zone to guard against infiltration of air. This is important because entrance of air through uncovered burner openings, or through working openings, alternately uncovered and closed, accounts for much of the lack of uniformity and excessive scale in practice maintained throughout the history of the industry.

✦ ✦ ✦

ADVOCATES of status quo ante in melting practice could well take a hint from this fundamental requirement and speculate on the possible error of their way in maintaining that the orthodox reverberatory practice is not a source of contamination — especially in light of the 14 points suggested as possible sources of contamination in the January, 1939, issue of WIRE AND WIRE PRODUCTS. It might also be considered in light of results of operation of many installations of bright annealing equipment designed on the principle of avoiding scale by the simple process of preventing entrance of the elements that form it. If oxide is not formed it is not necessary to remove it, either in melting or annealing—though, of course, scale is bound to form on the heated bar or rod in the rolling process, even though the bar is discharged from the furnace substantially scale-free. Opinions to the contrary notwithstanding, it is a fact that nearly all of the most objectionable scale heretofore considered as a natural accompaniment of heating wire bars, like the fleas on a dog, can be very materially decreased, if not substantially eliminated, by proper heating practice.

✦ ✦ ✦

Rolling Mills

BRASS and copper rolling and tube mills have, in the recent past, made relatively greater progress in production of more uniform products through better heating practice than any other branch of the industry. The irony of the situation is that the mills are now inclined to accept methods suggested more than twenty years ago and consistently, but unsuccessfully, urged during the ensuing period. The price they have paid for the affliction of "neophobia," previously referred to, is striking. As a result of such progress, many customers now receive more uniform metal; and the mills producing it profit by saving in time, labor, pickling, rejections, more rapid turnover, decreased service, and overall cost.

✦ ✦ ✦

BATCH methods of heating and cooling large, closely packed charges, with natural variation in uniformity of structure and surface condition — (irrespective of uniform temperature charts and fuel or electric furnaces with automatic control) are gradually being displaced by better methods to an extent heretofore unthought of in the industry. Bars, rods, tubes, sheets, strip, etc., are continuously produced uniformly and free from scale. Corresponding improvement has been effected in some fabricating shops, with advantage to all involved in the process—including the producer of the base metal—whether it be the product of the refinery or of the mill. Furthermore, some of the fabricators are thus being educated to acceptance of the fact that many past complaints of non-uniformity, heretofore made to producers of their base stock, are really due to their own abuse of the metal through improper methods of heating and cooling. Yet—there is much room for further improvement which refineries and mills should encourage in their own interest, if for no other reason than that of diminishing complaints and the possible loss of good customers.

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Other Development

OTHER interesting development includes that of bright annealing copper wire passing through an open flame. This, of itself, is a striking illustration of the fact that no one form of fuel or electricity (or equipment) has a monopoly on uniformity of structure or surface condition of the finished product; that we heat treat with heat—not with fuel or electricity as such; and that design and operation of the equipment is a controlling factor in the process. Opinion to the contrary in the past, often but a reflection of commercial factors, is as unsound and as outdated as many of the traditional notions and much of the technical tanglefoot that has bedeviled the industry in an effort to develop higher standards of quality and uniformity.

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CONTINUOUS bright annealing of individual sterling and nickel silver spoon blanks, and a great many other small fabricated products, is in marked contrast to the time-worn methods of annealing in batches with resultant lack of uniformity in structure and surface condition: also the higher cost represented by pickling, rejections, labor, etc. Advantages to the fabricator are accompanied by corrollary advantages to the mill supplying the base metal, through decreased complaints and rejections attributed to the metal, much of which, in fact, has been

heretofore due to poor heating practice.

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Atmosphere

ATMOSPHERES of nitrogen, carbon dioxide, steam or carbon monoxide—each by itself alone—have been considered suitable to avoid oxidation in heating and cooling. Of these CO is the only reducing gas; the others are neutral in that they will not oxidize or reduce at copper annealing temperature; CO_2 and steam react differently at high temperatures.

✦ ✦ ✦

OTHER atmospheres, such as those produced in burning city gas, propane and similar gases, frequently involve CO concentrates and concomitant hydrogen concentration. The latter may be objectionable in some high temperature operations—such as poling—as a cause of embrittlement, gasing, etc., and is considered undesirable. The trend has been toward low CO concentrations varying from 1% to 2% with the hydrogen content as low as possible or practically negligible. The ratio may be varied by adjustment of burner controls while the furnace is in operation.

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ATMOSPHERES generated by burning the city gas, propane and similar gases, with subsequent dehydration, are successfully used in bright annealing. The practice has been carried on to the extent of utilizing spent flue gases from the furnace, with subsequent dehydration, as a source of atmosphere. This avoids use of the separate atmosphere generator and, in large installations, has been found to decrease cost of operation materially. Dehydration, to remove water vapor from gases of combustion, is desirable in bright annealing to avoid condensation, and possibilty of water stain on the metal, in the cooling chamber. The amount of water condensed in operation of a mill type continuous furnace producing about 1,000 pounds of metal per hour is appreciable to the extent of its being objectionable.

Oxidation

OXIDATION is not entirely a matter of atmosphere—as is generally assumed. Composition of an oxide usually reflects the nature of the atmosphere affecting surface of the metal; but the **amount** of the oxide, which is usually the objectionable feature, is greatly influenced by the time and rate of heating and cooling, temperature head and manner of exposure to the atmosphere. Therefore, a method of exposure that will decrease the time automatically tends to decrease the **amount** of oxide, regardless of its composition—other factors being about equal.

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TIME of heating and cooling is decreased as the surface of a metal exposed is increased. This condition is approached as we provide the desirable condition of exposing the maximum posible surface to the action of the heating and cooling atmosphere. The method of exposure influences the surface of the metal just as it affects uniformity of structure of the metal itself.

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Extrusion

EXTRUSION of brass billets is materially affected by uniformity which usually reflects the method of heat application, although quality of the base metal is frequently held responsible for variations encountered in production. The prevalent method of heating, and form of equipment, is far below the standard of press design and operation. As with melting and wire bar practice, it seems to prevail because it has in the past; but this, too, is in line for a dose of what is needed to effect improvement.

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THE usual practice is to heat the larger billets in a chamber about 7′-0″ wide by 30′-0″ long, having an inclined floor intended to facilitate rolling action. In practice, the billets alternately rest and roll on the relatively cold floor in contact with each other. In movement, they are likely to pick up grit or small refractory particles that, ultimately, may find their way into the metal. Heat is alternately applied to but one section at a time. As a result, the billet is alternately heated and cooled, as the exposed surface changes in the process of moving through the chamber. Aside from the question of uniformity, the operation is severe on the men because of the hard labor involved; also on the furnace. On top of it all is the fundamental difficulty of maintaining a uniform temperature and atmosphere, in such a wide chamber, each end of which is alternately covered and uncovered by movement of the doors for charging and discharging the billets.

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POSSIBILITY of improvement in the extrusion process is demonstrated by an installation that provides for individual exposure, and substantially continuous movement of the billet on rollers arranged to permit uniform application of heat to substantially all of the circular surface. The heat application is actually more uniform then in wire bar practice. The result: — uniformity of billets, as automatically discharged to the press; more uniform and faster extrusion; better control of temperature and atmosphere; better working conditions for the men; and decreased overall cost—are an incentive to still further development, likely to avoid many difficulties heretofore experienced in capitalizing advantages of the extrusion process.

✦ ✦ ✦

Melting Practice

DEPENDABLE detail information relative to recent development in melting practice is not available to the extent of that acquired from the rolling mills that have lately found it profitable to consider progress in inverse proportion to secrecy of the past. However, it is apparent that continued development of better metal, and still better methods of production, with **OFHC**; and the **Coalesced process** (that avoids the usual melting and hot rolling) has forced recognition of the possibility of higher standards of quality and uniformity substantially along the lines considered at the Detroit

meeting—(aided and abetted by a bit of consumer demand). It is further apparent that other known efforts in direction of quality and uniformity, with better methods of melting, indicate growing acceptance of need for improvement which, naturally, leads to the conclusion that either the orthodox viewpoint has been wrong in the past or is wrong now.

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ONE trend toward an electric method, on the erroneous assumption that the desired results cannot be produced with cheaper fuel, has been reversed by a striking and successful movement in the diametrical opposite direction. This followed a suggestion, based on practical experience with both methods, that it might be well to attempt to capitalize the possibility indicated by practice in bright annealing (and actually reducing the oxide on hot rolled sheets in the process of annealing) in the open chamber of a fuel fired furnace—without a muffle or atmosphere generator—referred to in the preceding paper.

✦ ✦ ✦

ALL told, it appears as though there is now recognition of possibility for improvement even though precedent is lacking and some professional opinion has been discouraging. At any rate, comment over a wide area by recognized authorities is overwhelmingly in support of it. Substance of criticism, mostly oral, is confined to objection to disturbing the existing order of things and educating the customer to possibility of better methods actually necessary to give him what he wants. This is offset by the fact that it was bound to come eventually, so—why not now? The fact is that accepted heating methods of the past are not adapted to modern requirements for quality and uniformity.

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Variations in Poling

POLING molten copper, to remove impurities needlessly and wastefully introduced in orthodox reverbatory melting practice, is long over-ripe as a subject for constructive technical appraisal to determine the de facto relation of effect, cause, and origin. Ultimately, it will be considered as a form of modern technical voodooism that might be indulgently condoned in a history of ancient Tibet; but is decidedly out of place and date in the Phi Beta Kappa phase of the era of New Delirium, A.D., 1940. There's a bit of ancestor worship about it.

✦ ✦ ✦

INQUIRY is likely to determine cause of impurities and possibility of avoiding them; also variations that actually exist in accepted poling practice — including variations in the pole itself—rarely considered and less understood.

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IT is well to bear in mind that the "refining" phase of the poling process is affected by the action of gases from the wood generated by heat of the molten copper—not to some inherent value in the wood itself; that the trees vary in composition as cut; that they continue to vary in composition in storage—even though they are uniform in composition when stored in the yard as "poles"; that variation in composition of poles at the top and bottom of the storage pile may be induced by variable action of rain, ice, snow, humidity, velocity of wind, seasonal variation in temperature, etc.,—all of which may cause variation between the poles, or even in the pole itself. If the poles thus vary, particularly in the matter of moisture content, it is reasonable to assume that the volume and composition of gas generated from them also varies. It then follows that judgment and skill of the operator is a controlling factor in use of poles of different composition, and, necessarily, in control of uniformity. The mechanism and chemistry of such procedure seems out of step with a sound conception of control and uniformity:—even with the ironic effort to provide automatic temperature control as part of reverberatory equipment with which such poling is required in an intermittent process of operation.

✦ ✦ ✦

SUCH conditions considered with other potential sources of irregularity such as entrance of air through an uncovered poling opening; action of water vapor at high temperature; concentration of the gaseous and mechanical action of the pole within the localized effective poling area; direct local blast of incompletely burned gases of combustion on part of the charge in process of melting; variable skill and judgment of the operator, etc., suggest that such factors are either actual sources of irregularity or decidedly pregnant with possibilities. At any rate, equivalent conditions would not be tolerated in good practice for heating copper wire bars, cakes, etc., or in annealing fabricated products uniformly and without oxide. Such conditions seem to support the contention that the industry has long looked at, but either does not see or fails to recognize, a situation that is inconsistent with the result sought.

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JOYCE KILMER, the World War poet, wrote — "Only God can make a tree." If so, then copper refiners have long been engaged in a sinful process of destroying the work of God, or nature, and neglecting their duty in conservation of natural resources. It is long past time to snap out of such mental myopia—not only to effect better control of copper—but to remove ground for further New Deal indictment of industrial competence.

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IF this be heresy, then the industry is due for a good time in observing the process of proving it so; of explaining why it is necessary to remove from molten copper impurities that did not exist in the cathodes as charged into the reverberatory; and of demonstrating that if impurities are not established in the process of melting, then it is unnecessary to remove them in the process of refining. It will be found, as Shakespeare might have said if he were a copper man, that the fault is not with our stars—or the base copper—but with ourselves, in misunderstanding or misapplying fundamental principles of good heating practice that is part of the operating equipment of a southern

mammy cook. This may develop an indulgent attitude toward the practice of uneducated furnace operators who, in effect, too often determine what the customer actually receives, even though it is not what the metallurgist, or sales staff, intends he should have.

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Need for Better Control

NEED for better control of quality and uniformity in the mills and fabricating shops strengthens the belief, based on experience, that there should be better technical supervision of the several heating operations that so vitally affect both. One weak point in production of metal, and other products subjected to heat in the process of manufacture, is the almost universal misunderstanding —in technical as well as in production circles—of the actual relation of uniform pyrometer records to uniform products. There's a difference and distinction not generally sensed.

✦ ✦ ✦

PREVALENT practice is all too frequently the equivalent of producing uniform pyrometer charts and non-uniform products. This often accounts for difficulty of the government and large purchasers in procuring uniform products from different plants operating on identical specifications; and, at times, actually using metal from the same source—each submitting substantially the same pyrometer charts as evidence of uniformity. Refiners and rolling mills may frequently iron out some of their sales difficulties by studying heating methods of the fabricator before accepting his complaint of non-uniformity of the metal.

✦ ✦ ✦

Specifications

SPECIFICATIONS for production of fabricated metal products might well be amended in a manner calculated to guide the shops in the direction of uniformity without departing from fundamental metallurgical concepts.

✦ ✦ ✦

SPECIFICATIONS are usually incomplete from the shop viewpoint of producing the fabricated product. There is a distinction between a specification for the heat treatment of a metal and a product made from that metal. Geometry of the individual piece, (considered in relation to shape, size, weight, quantity, etc.) and method of transferring heat to and from that piece, logically indicate need for a difference in time and rate of heating and, possibly, of cooling different products made from the same metal. As determination of these controlling factors is usually left to the judgment—if any—of the furnace operator (in most of the non-ferrous plants) it is but natural that there should be variation in methods; and, therefore, in quality and uniformity.

✦ ✦ ✦

LOSS of time, money, and good feeling so frequently encountered in the old Spanish custom of passing the buck, would be materially decreased if the metallurgist and production staff would cooperate in development of **"process"** or **"production specifications"**—as an **amendment** to the usual metallurgical specifications —indicating preferred methods of heating or cooling calculated to control uniformity of the product —regardless of its composition.

✦ ✦ ✦

BRIEFLY, the thought is to develop a modern conception of uniformity—i.e. "either uniformly good or uniformly poor—but always uniform." With respect to this point of view, the metallurgical fraternity either overlooks the obvious, or is inclined to accept the status quo as in the shops. It is a reasonable conclusion, based on experience, to assume that this important point is not properly sensed. In fact, some metallurgists, who ought to know better, have actually expressed disapproval of it, even in light of rejected products from their own plants for which they were not actually responsible. Others who sense its value have encountered opposition in the shops because, forsooth, it reflects on the judgment of the production staff.

✦ ✦ ✦

The Human Element

CONCLUSION would be incomplete without a plea for better furnace operators to direct industrial heating processes that have more influence on quality than any other step in production or fabrication of metal.

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THE time-worn notion that "cheap" labor is good enough is as logically unsound as it is very expensive. It is a process of saving at the spigot and wasting at the bung. A good operator can usually more than pay his way through the savings effected by his superior skill.

✦ ✦ ✦

A GOOD annealer, except in operation of automatic furnaces, calls for more skill and judgment than a roller—believe it or not.

✦ ✦ ✦

A GOOD melter who consistently can produce uniform quality copper adapted to modern requirements with the usual reverberatory practice—under the variable conditions noted—is an angelic personage. He has been off the reservation for a long time and is unlikely to mess with run-of-mine mundane affairs in a copper refinery—unless and until the industry makes it worthwhile and provides the better methods and equipment necessary to deliver the goods.

If You Are Not A Member Of The Wire Association—Now Is A Good Time To Join!

The Annual Dues Are $10.00

For detailed information address

RICHARD E. BROWN, Secretary

THE WIRE ASSOCIATION

300 Main Street, Stamford, Conn.

Rustless Iron & Steel Expands Production Facilities

THE Rustless Iron and Steel Corporation recently held open house inspection of their new $2,500,000 addition to the only plant in the world which is devoted exclusively to the production of stainless steel and which employs unique processes which include every step in the manufacture of stainless steel ingots, billets, bars and wire from the virgin chrome ore to the finished product.

✦ ✦ ✦

THE event marked the completion of an expansion program inaugurated by the management in 1935 and intended for long-range accomplishment but which has been shortened to meet the requirements of a four-fold increase in market demand for the corporation's products.

✦ ✦ ✦

IN 1937, a $1,500,000 plant addition increased ingot capacity from 20,000 to 40,000 tons a year. This capacity was shortly found to be inadequate, and the current expansion recently completed has increased capacity to 75,000 tons a year. Operations have been stepped up to the point where the number of employes has increased in the past two years from 450 to more than 1,400.

✦ ✦ ✦

THE program just completed involved the demolition of practically all former buildings to make way for larger and more modern industrial structures, and the plant has been almost entirely equipped with new machinery.

✦ ✦ ✦

RUSTLESS is believed to be the first company in the stainless steel industry to adopt the same straight line system of production which is to be found among the automotive makers. Each product passes in a straight flow of manufacture through its own separate channel of plant operation, thus eliminating superfluous movements of men and materials. From ingot heating to shipping department bars and wire are produced within a single 1800-foot building.

✦ ✦ ✦

IN the straight line production system ingots first pass through a rolling mill where they are converted into billets. After being conditioned they are hot-rolled into bars and wire. These hot-rolled products then are annealed and pickled according to the specifications of individual customers. Stock which is to be cold finished is conditioned and then cold drawn or centerless ground. After a final rigid inspection the bars and wire are made ready for shipment.

✦ ✦ ✦

IN 1935 the principal producing equipment consisted of three six-ton electric furnaces, a 20-inch rolling mill and a five-stand nine-inch bar and rod mill. In that year the company had a melting capacity of 20,000 tons of ingots.

✦ ✦ ✦

MELTING facilities were changed in 1935 from the original three six-ton furnaces to three of 12-tons each. Two 16-ton furnaces were added in 1940 which increased the annual melting capacity to 75,000 tons, nearly four times the capacity of five years ago and almost twice the capacity of 1937.

The cold finishing department where hot rolled annealed bars are cold drawn through dies to secure close dimension tolerances, and to improve surface finish and physical properties. When an even higher surface finish is required a large battery of grinders and polishers in the same department is brought into use. ✦ ✦ ✦ ✦

Wire stock is drawn through dies in the cold finishing department. This operation provides close control of size, improves physical properties and gives the surface of the wire a mirror-like finish. ✦ ✦

TO the 20-inch and nine-inch mills which they had in 1935 was added a 12-inch bar mill in 1937. A 28-inch mill has been added in 1940 to produce billets, sheet bars and slabs, as well as a three-stand 12-inch mill and a seven-stand nine-inch mill for the production of bars or coils.

Table A

INGOT PRODUCTION	Stainless Steel (Percents)	All Steel (Percents)
1934	100	100
1935	132	131
1936	182	183
1937	280	194
1938	172	109
1939	321	181

✦ ✦ ✦

EQUIPMENT added to the cold finishing department has more than doubled production, not including a new cold roll mill for the production of special bar and wire shapes to meet present-day conditions and customer requirements. Finished bar and wire capacity is now about 1,500 tons a month, between four and five times the capacity in 1935. Other operations have been increased proportionately.

✦ ✦ ✦

THE products are sold in the form of billets, bars and wire to industrial users, jobbers, and distributors and in the form of ingots, blooms, slabs, billets and sheet bars to converting mills for further processing into sheets, strip and plates.

✦ ✦ ✦

UNTIL recently stainless steel was considered a part of the general steel industry, but its production has developed so rapidly in the last few years that it now stands apart as a separate industry in its own right.

✦ ✦ ✦

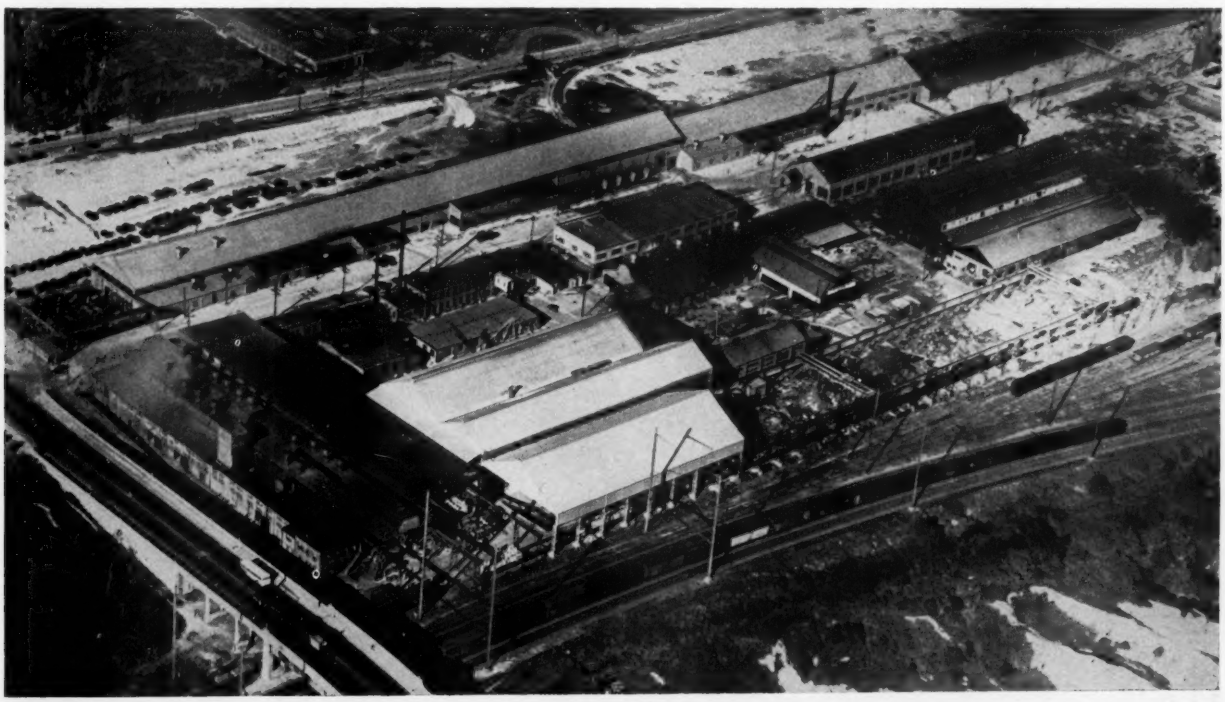
GROWTH in the production of stainless steel as compared to the production of the entire steel industry is shown in the following table which is based on data published by the American Iron and Steel Institute. With 1934 production equaling 100 percent the comparative production of stainless steel and all steel is as shown in Table A.

✦ ✦ ✦

TABLE B shows the growth of Rustless' ingot production in comparison with the entire stainless steel industry.

Table B

	Stainless Steel Industry Ingot Production (Percents)	Rustless Iron and Steel Corp. Ingot Production (Percents)
1934	100	100
1935	132	230
1936	182	367
1937	280	507
1938	172	229
1939	321	790
1940—Yearly rate based on six months ending June 30, 1940	Unknown	998



The world's only exclusive stainless steel plant, entirely rebuilt and its productivity increased four-fold to more than 75,000 tons annual melting capacity, all within the last five years.

Raw materials yards are shown at lower right center. Chrome ore is stored under the light colored roof at lower center. Next above it is the new melt shop and above it the new laboratories.

In the structure under three roof-levels through the center of the picture is housed the new 1,800-foot straight line production set-up. Ingots go in the left end and completely finished stainless steel bars and wire come out of the shipping department at the right end aboard trucks and railway cars. ✦

STATISTICS --- SEPTEMBER, 1940

PRODUCTION FOR SALE OF IRON AND STEEL PRODUCTS

AMERICAN IRON AND STEEL INSTITUTE
Capacity and Production for Sale of Iron and Steel Products

September - 1940
PERIOD

		Number of companies	Items	Annual Capacity Net tons	Production for Sale—Net Tons							
					Current Month				To Date (9 Months 1940)			
					Total	Per cent of capacity	Shipments ● Export	Shipments ● To members of the industry for conversion into further finished products	Total	Per Cent of capacity	Shipments ● Export	Shipments ● To members of the industry for conversion into further finished products
STEEL PRODUCTS	Ingots, blooms, billets, slabs, sheet bars, etc.	34	1	xxxxxxx	631,848	xxx	355,789	108,115	3,892,954	xxx	1,859,053	823,826
	Heavy structural shapes	8	2	5,205,300	310,944	73.0	55,638	xxxxxxx	2,082,099	53.4	285,530	xxxxxxx
	Steel piling	4	3	328,000	25,371	94.5	4,610	xxxxxxx	137,204	55.9	14,208	xxxxxxx
	Plates—Sheared and Universal	20	4	6,095,450	368,684	73.9	67,231	969	2,881,455	63.1	441,671	15,444
	Skelp	8	5	xxxxxxx	100,007	xxx	28,814	29,564	566,980	xxx	108,878	203,152
	Rails—Standard (over 60 lbs.)	4	6	3,647,600	79,113	26.5	24,825	xxxxxxx	1,219,854	44.7	168,451	xxxxxxx
	Light (60 lbs. and under)	6	7	306,800	13,305	53.0	9,597	xxxxxxx	86,540	37.9	32,981	xxxxxxx
	All other (Incl. girder, guard, etc.)	2	8	118,000	1,056	10.9	21	xxxxxxx	19,098	21.6	2,403	xxxxxxx
	Splice bar and tie plates	15	9	1,300,200	29,017	27.3	887	xxxxxxx	405,278	41.6	7,396	xxxxxxx
	Bars—Merchant	35	10	xxxxxxx	453,431	xxx	130,799	30,632	3,259,688	xxx	528,292	249,839
	Concrete reinforcing—New billet	16	11	xxxxxxx	111,231	xxx	17,064	xxxxxxx	946,796	xxx	222,268	xxxxxxx
	Rerolling	18	12	xxxxxxx	12,344	xxx	1,021	xxxxxxx	108,042	xxx	6,130	xxxxxxx
	Cold finished—Carbon	18	13	xxxxxxx	60,660	xxx	2,378	xxxxxxx	482,788	xxx	12,969	xxxxxxx
	Alloy—Hot rolled	16	14	xxxxxxx	98,356	xxx	12,130	8,207	694,714	xxx	60,834	40,420
	Cold finished	15	15	xxxxxxx	8,892	xxx	676	xxxxxxx	67,709	xxx	2,648	xxxxxxx
	Hoops and baling bands	5	16	xxxxxxx	8,158	xxx	545	xxxxxxx	77,616	xxx	7,112	xxxxxxx
	TOTAL BARS	54	17	12,372,465	753,072	74.3	164,613	38,839	5,637,353	60.9	840,253	299,259
	Tool steel bars (rolled and forged)	15	18	110,220	6,270	69.5	663	xxxxxxx	50,802	61.6	4,264	xxxxxxx
	Pipe and tube—B. W.	13	19	1,851,860	107,915	71.2	6,564	xxxxxxx	758,723	54.7	57,023	xxxxxxx
	L. W.	10	20	1,246,340	29,746	29.2	3,087	xxxxxxx	256,404	27.5	26,018	xxxxxxx
	Electric weld	5	21	735,520	28,162	46.8	2,803	xxxxxxx	214,241	38.9	22,808	xxxxxxx
	Seamless	15	22	3,159,840	168,860	65.3	45,936	xxxxxxx	1,309,861	55.4	159,896	xxxxxxx
	Conduit	6	23	151,145	7,784	62.9	83	xxxxxxx	53,314	47.1	1,450	xxxxxxx
	Mechanical Tubing	13	24	554,825	28,371	62.5	3,563	xxxxxxx	206,400	49.7	16,430	xxxxxxx
	Wire rods	18	25	xxxxxxx	138,009	xxx	55,873	21,046	879,220	xxx	282,167	137,249
	Wire—Drawn	37	26	2,255,210	131,846	71.4	16,976	1,255	1,050,590	62.2	130,077	8,331
	Nails and staples	19	27	1,091,690	53,983	60.4	3,755	xxxxxxx	450,038	55.1	48,418	xxxxxxx
	Barbed and twisted	16	28	438,270	17,861	49.8	6,986	xxxxxxx	154,587	47.1	37,934	xxxxxxx
	Woven wire fence	15	29	772,790	13,503	21.3	118	xxxxxxx	176,781	30.6	1,678	xxxxxxx
	Bale ties	11	30	119,050	6,115	62.7	93	xxxxxxx	54,628	61.3	237	xxxxxxx
	All other wire products	5	31	27,030	473	21.4	-	xxxxxxx	3,964	19.6	-	xxxxxxx
	Fence posts	13	32	147,485	4,314	35.7	118	xxxxxxx	41,363	37.5	810	xxxxxxx
	Black plate	12	33	653,295	20,476	38.3	372	19	263,808	53.9	33,803	55,982
	Tin plate—Hot rolled	9	34	1,201,960	30,286	30.8	1,767	xxxxxxx	358,646	39.9	72,696	xxxxxxx
	Cold reduced	10	35	2,930,860	162,697	67.8	15,669	xxxxxxx	1,741,385	79.4	279,659	xxxxxxx
	Sheets—Hot rolled	26	36	xxxxxxx	530,411	xxx	45,024	17,603	4,027,356	xxx	397,588	112,893
	Galvanized	16	37	xxxxxxx	138,375	xxx	12,497	xxxxxxx	1,023,023	xxx	124,011	xxxxxxx
	Cold rolled	18	38	xxxxxxx	219,416	xxx	4,953	xxxxxxx	1,660,908	xxx	61,471	xxxxxxx
	All other	15	39	xxxxxxx	48,578	xxx	1,954	xxxxxxx	421,578	xxx	18,789	xxxxxxx
	TOTAL SHEETS	27	40	13,255,610	936,780	86.3	64,488	17,603	7,132,865	71.9	601,859	112,893
	Strip—Hot rolled	24	41	3,525,110	137,220	47.5	8,955	16,414	1,049,033	39.7	64,596	123,994
	Cold rolled	35	42	1,313,360	70,404	65.5	1,467	xxxxxxx	532,901	54.2	13,256	xxxxxxx
	Wheels (car, rolled steel)	5	43	424,385	14,603	42.0	42	xxxxxxx	138,923	43.7	2,481	xxxxxxx
	Axles	5	44	472,280	10,903	28.2	26	xxxxxxx	66,727	18.9	1,803	xxxxxxx
	Track spikes	11	45	327,275	6,434	24.0	126	xxxxxxx	80,636	32.9	2,913	xxxxxxx
	All other	3	46	9,100	1,123	150.7	-	xxxxxxx	7,935	116.5	-	xxxxxxx
	TOTAL STEEL PRODUCTS	134	47	xxxxxxx	4,446,555	xxx	951,555	233,824	33,962,990	xxx	5,623,100	1,780,130
	Estimated total steel finishing capacity based on a yield from ingots of 68.9 %	-	48	53,946,300	xxxxxxx	95.4	xxxxx	xxxxxxx	xxxxxxx	79.7	xxxxxxx	xxxxxxx
IRON PRODUCTS	Pig iron, ferro manganese and spiegel	26	49	xxxxxxx	566,136	xxx	53,178	164,024	4,156,479	xxx	422,961	1,113,296
	Ingot moulds	4	50	xxxxxxx	48,609	xxx	731	xxxxxxx	337,076	xxx	3,214	xxxxxxx
	Bars	10	51	160,600	2,890	22.0	1	138	22,407	18.6	106	1,643
	Pipe and tubes	3	52	109,377	4,155	46.4	13	xxxxxxx	29,887	36.5	698	xxxxxxx
	All other	3	53	71,180	1,048	18.0	301	223	9,037	17.0	1,861	2,326
	TOTAL IRON PRODUCTS (ITEMS 51 to 53)	12	54	276,247	8,093	35.8	315	361	61,331	29.7	2,665	3,969

Total number of companies included - 153

Total steel products produced for sale, less shipments to members of the industry for conversion into further finished products: Current month 4,212,731 *N.T.;* 95.4 *% of Finishing Capacity.*
To date 32,182,860 *N.T.;* 79.7 *% of Finishing Capacity.*
The above tonnages represent 68.9 *% of the ingots produced by companies whose products are included above.*

If You Are Not A Member Of The Wire Association—Now Is A Good Time To Join!
The Annual Dues Are $10.00
For detailed information address
RICHARD E. BROWN, Secretary
THE WIRE ASSOCIATION
300 Main Street, Stamford, Conn.

Paul M. Macklin, Executive Vice President, Wickwire Spencer Steel Company

BORN in Calais, Maine, Dec. 10, 1886, Mr. Macklin was principal of Grafton High, Fairhaven High and Southbridge High Schools before becoming associated with the Goddard Works of the Wickwire Spencer Steel Co., Worcester, Mass.

✦ ✦ ✦

ONE of a family of fifteen children, he was graduated from the Anson, Me. High School and continued his studies at Clark University as a member of the class of 1907.

✦ ✦ ✦

IN 1918, after twelve years of teaching he joined the Wickwire Spencer Steel Co. as a mechanic in a flat wire rolling mill. The next two years he was foreman of the heat treating room and superintendent of the high carbon department at the Goddard Works.

✦ ✦ ✦

SIX years later he was appointed vice-president and general manager, the position he held at the time of his death.

✦ ✦ ✦

MR. MACKLIN was active in a number of clubs, including the New York Engineers Club, New York Athletic Club, the Worcester and Westchester Country Clubs.

PAUL M. MACKLIN
Executive Vice President
Wickwire Spencer Steel Co.

HIS death occurred by drowning while on a hunting trip in the Allagash Lake region of the state of Maine.

✦ ✦ ✦

Herman W. Koerner, President, Universal Wire & Iron Co.

HERMAN W. KOERNER, 79, president of Universal Wire & Iron Co., Milwaukee, passed away at his home in Milwaukee, on October 27.

Iron and Steel Exports

UNITED STATES exports of iron and steel (scrap excepted) declined 7.7 percent in quantity and 6 percent in value in September compared with the record August trade. September shipments, larger than those of any other month except August, totaled 965,444 gross tons valued at $50,630,630 as compared with the 1,046,084 tons valued at $53,870,693 in August and with the 244,933 ton, $11,142,216 trade of September 1939.

✦ ✦ ✦

DURING the first 9 months of 1940 exports of iron and steel totaled 5,489,951 tons valued at $340,983,531—more than 3½ times as much by weight and over 3 times as valuable as the trade of the January-September period of 1939, which amounted to 1,516,988 tons valued at $111,268,825.

✦ ✦ ✦

DURING recent months, the movement of heavy products featured the September export trade. Nonalloy ingots, blooms, billets, and similar products were the leading classes of materials exported during the month. Of the 353,448 ton total, 312,949 tons went to the United Kingdom, 25,165 tons to Canada, and 10,709 tons to Japan. Pig iron ranked second in the trade with the United Kingdom taking 82,744 tons of the 84,677 ton total. Third place went to plain structural shapes with total shipments amounting to 69,470 tons, of which 41,863 went to the United Kingdom, 9,784 to Japan, and 9,508 to Canada.

ROUGHLY three-fifths of the September exports (607,931 tons) were dispatched to the United Kingdom, whose takings, in addition to the items already listed, included 36,323 tons of alloy ingots, blooms, and related products; 34,068 tons of non-alloy "other" plates; 27,636 tons of wire rods; 22,398 tons of nonalloy "other" steel bars; and 17,970 tons of heavy rails. Second ranking purchaser was Canada, which took 105,933 tons followed by Japan with 54,845 tons, and the Union of South Africa, 34,255 tons.

✦ ✦ ✦

EXPORTS of scrap declined sharply in September. Exports in August totaled 355,991 gross tons valued at $6,078,241, but declined to 255,608 tons valued at $4,437,019 in September. In September 1939 scrap exports amounted to 330,680 tons valued at $5,100,069.

✦ ✦ ✦

CUMULATIVE 9-month exports were reported at 2,419,833 tons valued at $41,103,194 against 2,761,594 tons valued at $40,842,079 exported in the January-September period of 1939.

✦ ✦ ✦

THE September scrap total of 255,608 tons included 251,116 tons of iron and steel scrap, 162 tons of tin plate circles, 19 tons of waste-waste tin plate, and 4,311 tons of terne plate scrap. The month's trade in iron and steel scrap included shipments amounting to 148,332 tons to Japan, 75,049 tons to the United Kingdom, and of 22,298 tons to Canada. Switzerland took 87 tons, the Union of South Africa 63 tons, and Venezuela 12 tons of tin plate circles. Turkey was the sole buyer of waste-waste tin plate and the United Kingdom of terne plate scrap during the month.

✦ ✦ ✦

Imports

THE volume of iron and steel products (scrap excepted) moving into the United States in September rose in quantity but declined sharply in value compared with August. September receipts totaled 2,542 gross tons valued at $160,988 in September against 2,-

089 tons valued at $516,187 in August, and were less than one-tenth the volume imported in September 1939 when receipts reached 26,658 tons valued at $1,431,318.

✦ ✦ ✦

THE cumulative 9-month totals for 1940 stand at 46,809 tons of iron and steel valued at $5,528,578 against 240,964 tons valued at $14,097,302 brought in during the comparable period of 1939.

✦ ✦ ✦

PIG iron was the leading product imported in September with British India supplying 1,794 tons of the 1,830 ton total. The only other items of any consequence in this trade were "other pipe," 336 tons, of which 163 tons came from Sweden and 135 tons from Curacao, and 137 tons of ferrosilicon all of which came from Canada.

✦ ✦ ✦

LEADING countries of origin in September were British India, Sweden, Canada, and Curacao. Scrap imports were negligible during September.

Wood Screws

EXPORTS of iron and steel wood screws during September, 1940, totaled 146,568 gross valued at $23,666. Of this total British India took 50,280 gross, valued at $8,764; Colombia, 21,547 gross valued at $3,347; Union of South Africa, 18,472 gross valued at $3,133; Cuba, 14,552 gross valued at $1,692; Mexico, 7,077 gross valued at $916; Argentina, 6,200 gross valued at $633; Venezuela, 6,075 gross valued at $1,430; Nicaragua, 5,633 gross valued at $1,036; Canada, 5,483 gross valued at $638; Paraguay, 4,000 gross valued at $420; Ecuador, 2,220 gross valued at $280; and Bolivia, 1,856 gross valued at $256.

✦ ✦ ✦

EXPORTS of brass wood screws during the same month totaled 8,245 gross valued at $3,762. Of this total Cuba took 3,124 gross valued at $1,297; Argentina, 1,450 gross valued at $292; Philippine Islands, 670 gross valued at $135; Canada, 645 gross valued at $785; Colombia, 530 gross valued at $339; Union of South Africa, 500 gross valued at $216; Venezuela, 453 gross valued at $142; Peru, 297 gross valued at $145; Mexico, 251 gross valued at $173; and Costa Rica, 142 gross valued at $125.

✦ ✦ ✦

IMPORTS of wood screws during the same period were none.

✦ ✦ ✦

Argentine Tungsten Mine Leased By U. S. Firm

A UNITED Press dispatch from Buenos Aires says that the leasing of all tungsten mines in the Department of Iglesias, San Juan Province, by the United States firm of Granfor, Keen & Company, was regarded as a solution to the unemployment problem in that region.

✦ ✦ ✦

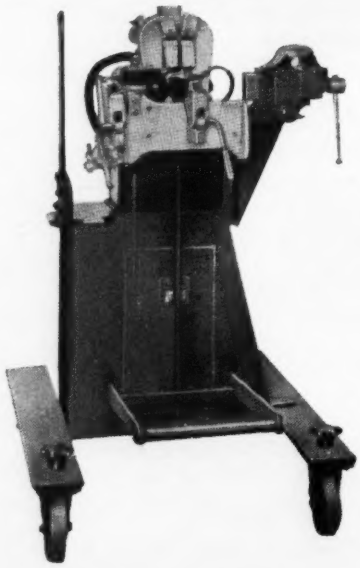
THE company paid $700,000 for a ten-year lease on that center of Argentina's richest tungsten area. This country is the fifth largest producer of tungsten used in shell projectiles and armor plate, having produced 1,054 tons in 1938, its best year.

MICROMETER PRECISION MICRO-WELD TRADE MARK REG. U. S. PAT. OFF.

CONTINUOUS IMPROVEMENT

MICRO-WELDERS with dial indicating annealing attachments are now available for high carbon wire.

There is positive control of annealing temperature and already hundreds of these special MICRO-WELDERS are proving their dependability and satisfactory performance with leading manufacturers.



MICRO PRODUCTS COMPANY
20 NORTH WACKER DRIVE, CHICAGO, ILL.
Telephone, State 7468

George W. Nelson, Superintendent, Buffalo Works, Wickwire Spencer Steel Co.

MR. GEORGE W. NELSON was born in Worcester, Mass., Feb. 22, 1892 and was a graduate of Millbury Street Preparatory School and Worcester Polytechnic Institute, class of 1914.

✦ ✦ ✦

AFTER his graduation from Tech, he was associated with the Union Carbide Co. at Buffalo and the South Works of the American Steel and Wire Co. After a few years' employment at the Goddard Works of the Wickwire Spencer Steel Co., he joined Brewer and Co. as manager of its import and export department, spending much of this time in Shanghai, China.

✦ ✦ ✦

RETURNING to Wickwire Spencer, he was promoted to foreman, asst. superintendent, then superintendent of their Clinton Works and in 1936 was made superintendent of the Goddard Works. With the completion of Wickwire's new wire mill at Buffalo he was appointed superintendent of the Buffalo Works, which position he held at the time of his death.

✦ ✦ ✦

MR. NELSON served in World War I as a lieutenant observer in an Aero Squadron and with the Army of Occupation in Germany. He had been a member of the Organized Reserves, holding the rank of Major in the 365th Field Artillery until his removal to Buffalo.

✦ ✦ ✦

MR. NELSON was a member of the Worcester Economic Club, a 32nd degree Mason and a Shriner.

✦ ✦ ✦

MR. NELSON'S death occurred by drowning while on a hunting trip in the Allagash Lake Region of the state of Maine.

✦ ✦ ✦

P. J. Darling, Gen. Sales Mgr., Steel Sales Corp.

P. J. DARLING has been appointed general sales manager of the Steel Sales Corp., Chicago. He has been with the firm's sales force for 11 years.

THIS *Wire*

HAS A "GIFT" FOR PRODUCTION!

The holiday spirit of giving prevails the year 'round with Keystone wire. What better gift than smoothed out production, increased product quality, low costs? Samples of regularly stocked wires will give you an idea of Keystone's UNIFORMITY in tensile strength, analysis, gauge and finish. If you need a SPECIAL wire, Keystone will create it. Why not investigate the "gift" possibilities of Keystone wires this Christmas season?

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HIGH CARBON OR LOW CARBON

SAMSON SPRING WIRE

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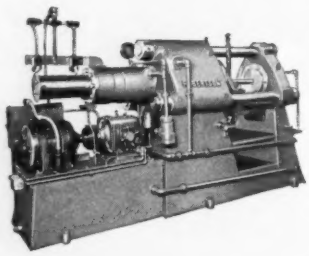
Bright-Tinned Coppered Annealed Galvanized

NOW. . . *semi-automatic!*

Robertson proudly announces a new feature in a horizontal extrusion press already acclaimed for its economy and efficiency in extruding miscellaneous non-ferrous alloys, lead and its alloys, solder and solder wire and flux core solder wire. New finger-tip control sends the press forward through the extrusion stroke and returns it to starting position . . . without any other attention! Just a touch on a button does it, a child could operate this press. Ask about it; write—



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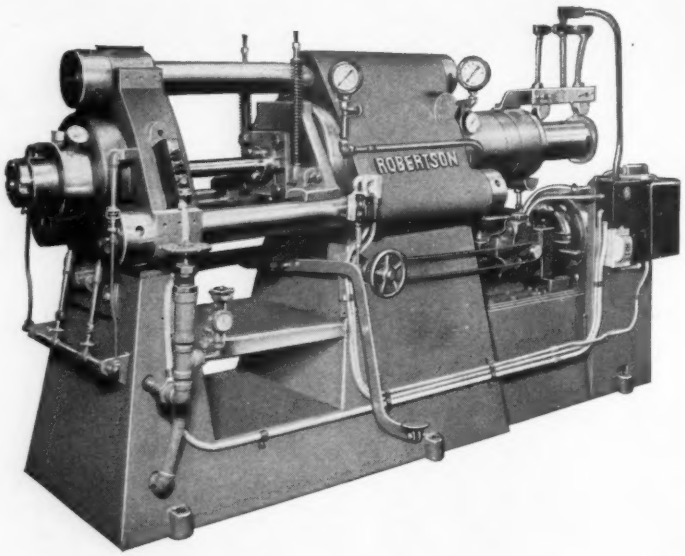


ROBERTSON *Improved*
horizontal extrusion press

The National Machinery Company Of Tiffin, Ohio, Held "Open House" from October 27 to 30, 1940, At Their Plant

THE object of our Open House was to show the people in this city and the surrounding district, wherein the product made upon our machines enters into their everyday lives, and assists in creating employment and making it possible for "more people to have more things".

✦ ✦ ✦

WE build Bolt, Nut, Rivet and Wire Nail Machinery, and both Cold and Hot Heading and Forging Machines, and also High Speed Forging Maxipresses. Many special shapes of screws and bolts have been developed upon our Cold Headers, at great effort and expense. The Cold Headers are also used for making many special parts and fittings, and the Heading and

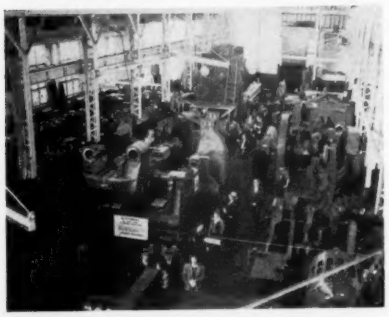
Forging Machines produce an unlimited variety of intricate forgings, which in many cases could not be made by hand. The net result of this development is that washing machines, radios, electric stoves, agricultural implements, tractors, automobiles, aeroplanes and an innumerable number of other articles can be sold more economically, which naturally broadens the market and creates employment. It is such Improvement and Development by all Industry, which lowers costs and broadens markets, so that the men that are displaced by machinery are able to find employment for the production of goods entering into our higher standard of living.

✦ ✦ ✦

OUR plant was in operation so that our visitors could see the way machinery is built, and we had a number of both Cold and

Hot Heading and Forging Machines in operation, showing the work produced. Balls were being made for ball bearings. Aluminum rivets and special lock nuts were being produced for aeroplanes. Machines were making bolts, tapping nuts, rolling threads and producing various forgings. The local merchants provided an exhibit of almost every known article of commerce, from a typewriter to a tractor, which enabled us to show wherein the product made on our machines was used in each article. It is quite a revelation to note the extent to which the Header and Forging Machine assist in making the chassis and engine parts of an automobile. From the front wheel spindle to the rear axle drive shaft, it becomes obvious that without Headers and Forging Machines, the cost of automobiles would be prohibitive.

✦ ✦ ✦



THE students in the higher grades were shown through the plant in the afternoon. The plant was in operation during Sunday afternoon, and also Monday, Tuesday and Wednesday evenings, and during that time we had more than 15,000 visitors.

✦ ✦ ✦

EVIDENTLY, if more of this same thing were done by Industry, there would be a better understanding about the interrelationship between Industry and the Public. One of the large signs posted by The National stated:

The Most Important Thing
To Every Man
IS HIS JOB
SO HE SHOULD KNOW HOW
JOBS ARE CREATED
Every man, and particularly the

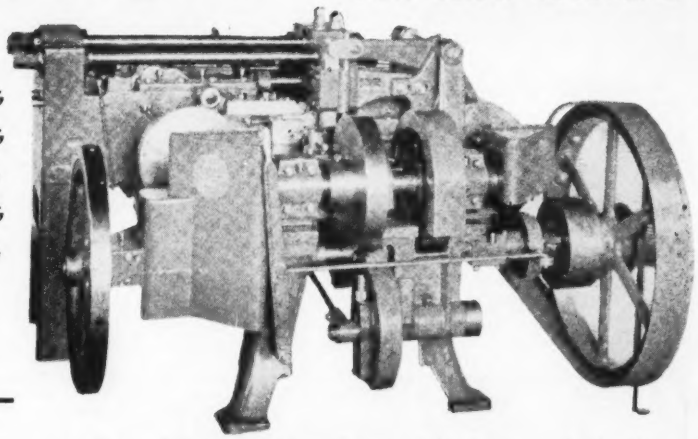
(*Please turn to Page 765*)

TELEPHONE cables with aluminum instead of copper cores have been developed in Germany. Formerly, telephone cables in Germany had 0.9 or 1.4 millimeter copper strands, which are now being replaced by 1.8 and 1.15 millimeter aluminum strands. This leads to thicker cables and a long-distance telephone cable with 114 strand pairs requires 31 percent more lead for armoring than does a regular copper cable; nevertheless, the aluminum cable as against copper is reported to save 54 percent in foreign exchange. The technical problems of eliminating the formation of galvanic elements in moist air by the interaction of copper and aluminum in old-system with new-system cables, with aluminum wires on copper contacts has been solved by the use of copper-plated aluminum wire containing 20 to 25 percent of copper and by japanning bimetallic contacts.

NILSON

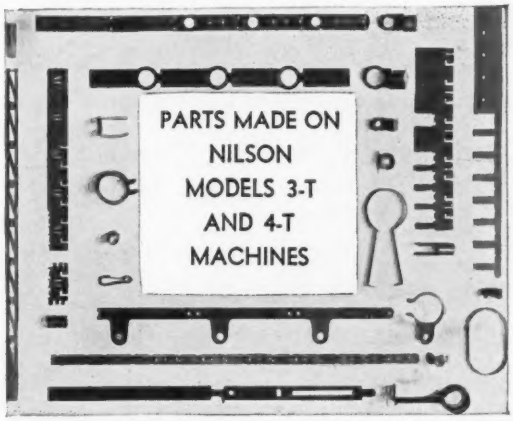
AUTOMATIC PRESS
AND
FOUR SLIDE MACHINE

FOR
SWAGING
STAMPING
PIERCING
BLANKING
FORMING
OF
COILED
METAL



A General Purpose, Heavy Duty Fabricating and Metal Forming Machine.

WE Build machines for forming Paper Clips, Buckles, Gate Hooks, Coat and Hat Hooks, Ceiling Hooks, Wire Ears, Cable Rings, Screw Eyes, Sash Chains, Automobile Side Chains, Flat Open Link Chains, Staples, Cotter Pins, Hose Clamps, Etc. and Wire Straighteners, Wire Reels, Frame Bending Machines and Special Presses.



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For Complete Details Address —

THE A. H. NILSON MACHINE CO.
BRIDGEPORT, CONN., U. S. A.

'Round the World With the Wire Industry

THE recent barter agreement between Spain and Argentine, (Wheat and maize in exchange for steel), also contains a certain quantity of wire and wire products, approximately 1,200 tons. The Spanish wire industry has not been able to supply the country's need in full during the first half of this year, but has recently developed as it is possible to get wire machinery from Germany. Germany supplies wire rod to Spain and has contracted for wire machinery worth $113,000 for various Spanish factories.

✦ ✦ ✦

AT the Leipzig autumn Fair and following this, wire machinery worth approximately $276,000 has been sold to Manchukuo and Japan. German exports to these countries and also to Siam and China via Siberia are growing from month to month as special transit convoys have been organized on the Siberian Railway. Shipments from the Ruhr to Tokyo require approximately 19 days at present. Not only wire machinery but other wire products such as music wire, wire ropes, wire mesh and wire products which can stand the high transport cost are thus sold and during the month of August the value of wire products shipped via Siberia to the Far East exceded $110,000 of which the larger part was wire ropes.

✦ ✦ ✦

European Wire Export Prices

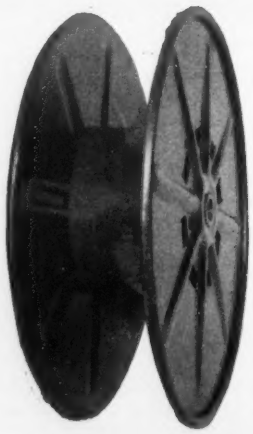
THE wire export prices in Europe are dominated by the German cartel. Domestic prices are now quoted to all markets, except the Far East and Portugal, which get quotations about equal to prices quoted by the United States wire industry. German wire sales include Afghanistan, Iran and Siam. In spite of political tension, sales to Greece and Turkey are also continuing. At present about 40% of the whole German wire production is sold for export. The Belgian wire industry, which is almost at the same level of operations as it was in May, sells through the Belgian-German export organization of Ougree-O. Wolff, at the same prices as the German works. The situation of the wire industry in the non-occupied section of France is very bad, due to lack of raw materials, as supplies of wire rods from Northern France have not yet been reinstated. Between Spain and Portugal exists now a direct Railway-transit service to any German Railway station, so that direct shipments to and from Germany are possible. Part of German wire exports to Italy go from Lorraine via France.

MOSSBERG PRESSED STEEL CORP.

Greater service from a new All Welded Steel Take Off Reel designed to meet present day requirements.

Usual maintenance expense eliminated by adoption of this new design wherein all parts are welded into one homogeneous unit.

Reel sides are embossed with radial reinforcing ribs for increased rigidity with rolled edges for additional strength and to facilitate handling.



All Welded Steel Take Off Reel

Complete line of spools and reels for both processing and shipping all kinds of bare and insulated wires and cables. (Send for Catalogue W-104)

MOSSBERG
PRESSED STEEL CORP.
18 West Street
Attleboro, Massachusetts, U. S. A.

Ross Whitehead & Co., Ltd.,
Montreal & Toronto, Canada.

James Day (Machinery), Ltd., 66, Bartholomew Close, London, E. C. 1., England.

Russian Molybdenum and Tungsten

U. S. S. R.—Soviet geologists began development of a molybdenum and tungsten deposit during 1934, near the village of Nizhni Baksan, close to Mount Elbrus in the Caucasus. The first section of the metallurgical plant of the "Combine," consisting of a crushing mill and concentrating plant, is now reported to have been completed and equipment is being installed. Ore is delivered from the mine, which is situated 9,840 feet above sea level, by rope conveyor. Some delay is reported to have occurred in deliveries of equipment for the enterprise. (Soviet Press.)

✦ ✦ ✦

Salt Bath Furnace

NEW twenty page Catalog 107 describing the Ajax-Hultgren Electric Salt Bath Furnace. Gives detailed data on all heat treating applications such as carburizing, cyanide hardening, hardening carbon and high speed steel tools without scale or decarb, heat treating aluminum alloys, tempering steel products, heating for forging, brazing, etc.

✦ ✦ ✦

National Machinery Co. Held "Open House"

(*Continued from Page 763*)

young man, should know that his chance for a job is greatly increased by

INVENTION AND DEVELOPMENT AND NEW ENTERPRISES

✦ ✦ ✦

THE range of National Machines on exhibit extended from a small Nut Tapper weighing 150 lbs. to the world's largest Forging Machine weighing 500,000 lbs.

1941 Convention To Be Held In Philadelphia

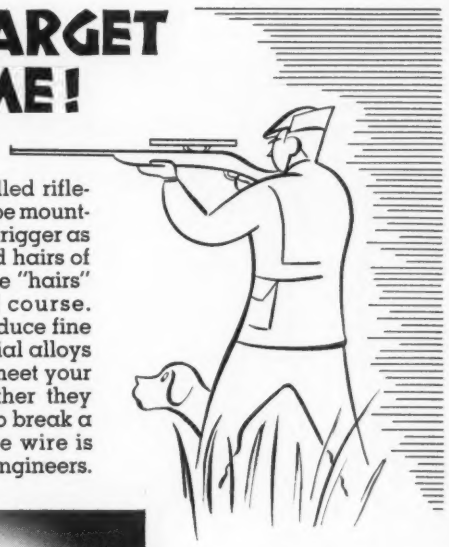
THE Twenty-third National Metal Congress will be held at Convention Auditorium and Commercial Museum, Philadelphia, October 20th to 24th, 1941.

✦ ✦ ✦

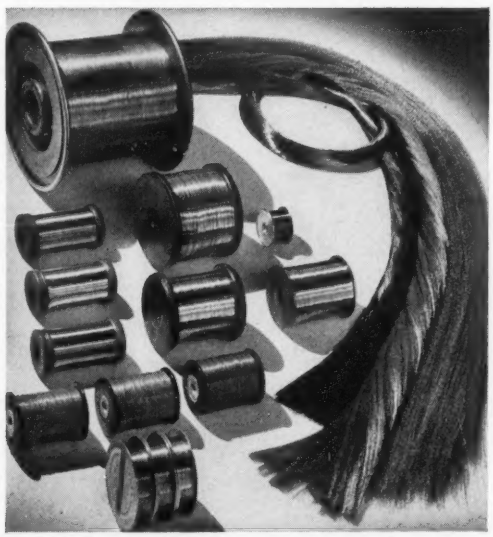
THE Wire Association will also hold its Convention during the same period at Philadelphia in accordance with arrangements made with the American Society for Metals and on the same basis as in past years.

THE Exposition space for 1941 should be arranged for by exhibitors as early as possible. The space list announcement for the Philadelphia show will be mailed out by the American Society for Metals in December and space assignments will be made in January. The 1940 National Metal Congress was exceptionally successful. The total registration was 32,478 and it is estimated that the attendance was three times the registration.

ON THE TARGET EVERY TIME!



For accurate shooting, the skilled rifleman sights through the telescope mounted on his gun. He squeezes the trigger as the bulls-eye meets the crossed hairs of his sight. But look closely — the "hairs" are *wire*... Callite Wire, of course. Callite has the facilities to produce fine wires... of standard and special alloys ... in any size or shape... to meet your individual requirements whether they be for gun-sights or go-carts. To break a production bottle-neck where wire is involved, consult the Callite engineers.



Write for

COMPLETE DETAILS

Callite wires are available in aluminum, steel, stainless steel, Everdur, brass — all grades, brush wire, commercial bronze, Fourdrinier, phosphor bronze, nickel-silver alloys and in combinations of these and other alloys. In round, flat and special shapes in sizes down to .002".

CALLITE WIRES

CALLITE-TUNGSTEN CORPORATION

564-39th STREET • UNION CITY, N. J.

Branch Offices: Chicago, Ill. • Cleveland, O.

A WIRE FOR EVERY NEED — CALLITE TUNGSTEN — CT

A Review of Recent Wire Patents

No. 2,216,189, METHOD AND APPARATUS FOR INSERTING CORES IN CABLES, patented October 1, 1940 by George H. Ennis, Long Beach, California, assignor of one-half to Robert V. Funk, Long Beach, Calif.

This apparatus is adapted for inserting cores in preformed wire cables. There are 22 claims.

✦ ✦ ✦

No. 2,216,211, METHOD AND APPARATUS FOR PICKLING METAL COILS, patented October 1, 1940 by Stone Nyberg, Dover, and Herman C. Cappel, New Philadelphia, Ohio, assignors to Agnes J. Reeves Greer, Morgantown, West Virginia.

The method of pickling, washing or treating a coil of metal supported upon a mandrel which includes transferring the coil from one bath to another bath and rotating the coil around its axis throughout the entire time it is being transferred from one bath to the other.

✦ ✦ ✦

No. 2,216,224, APPARATUS FOR COILING WIRE OR THE LIKE, patented October 1, 1940 by Carl O. Bruestle, Rahway, N. J., assignor to Elevator Supplies Company, Incorporated, Rahway, N. J., a corporation of New Jersey.

In this apparatus, the drum is secured against the pull of wire under high tension, while, at the same time, coils wound on the drum may be easily removed.

Complete Descriptions and Drawings of Patents May Be Had for 25 cents. Address, Wire & Wire Products, 300 Main St., Stamford, Conn.

No. 2,216,225, APPARATUS FOR COILING WIRE OR THE LIKE, patented October 1, 1940 by Carl O. Bruestle, Rahway, N. J., assignor to Elevator Supplies Company, Incorporated, Rahway, N. J., a corporation of New Jersey.

A new take-up control for the wire being wound, is provided in this patent.

✦ ✦ ✦

No. 2,216,381, SCREW, patented October 1, 1940 by Maxwell A. West, Portland, and George E. West, Sherwood, Oregon, assignors of forty-nine one-hundredths to W. H. Holmes and Philip C. Smith, both of Portland, Oregon.

In this screw, the invention resides in the head, there being a main slot and two spline slots, shorter than the main slot.

✦ ✦ ✦

No. 2,216,382, SCREW, patented October 1, 1940 by Maxwell A. West, Portland, and George E. West, Sherwood, Oregon, assignors of forty-nine one-hundredths to W. H. Holmes and Philip C. Smith, both of Portland, Oregon.

The screw head is provided with a driving recess comprising a plurality of similar, symetrically-spaced, radial slots, the slots intersecting in the screw axis, terminating short of the periphery of the screw head, the end wall of each slot sloping downwardly and inwardly.

✦ ✦ ✦

No. 2,216,435, COMPOSITION OF MATTER AND ELECTRICAL CONDUCTOR CABLE CONTAINING THE SAME, patented October 1, 1940 by John F. Eckel, Cranford, N. J., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York.

For wire conductors, the inventor provides, as an inner sheath coating, comprising 25% to 75% of rosin, 20% to 50% of rosin oil and 5% to 25% of polymerized isobutylene to increase adhesiveness, fluxing power and temperature plasticity character.

✦ ✦ ✦

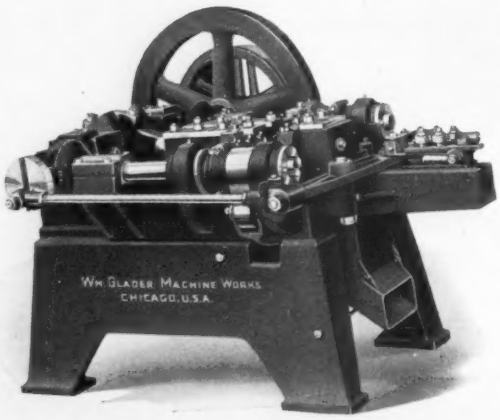
No. Re. 21,596, MACHINE AND METHOD FOR TWISTING METAL WIRES, patented October 8, 1940 by Karl Johan Jensen, Nydalen, v. Aker, near Oslo, Norway, assignor, by mesne assignments, to Screw Nail Corporation of America, Wilmington, Del., a corporation of Delaware.

The method is adapted for twisting metal wire into threaded wire of substantially uniform pitch irrespective of any non-uniform hardness of the wire.

✦ ✦ ✦

No. 2,217,156, SPRING ASSEMBLY, patented October 8, 1940 by Elmer J.

HIGH SPEED WIRE NAIL MACHINE



WM. GLADER MACHINE WORKS

210 N. Racine Ave. Chicago, Illinois

Glader Machines on large head, single-blow roofing nails can be seen in operation at any of the independent wire mills in the United States.

The production figures on common nails shown below, are guaranteed.

SIZE MACH.	SIZE WIRE	MAX. LENGTH OF WIRE	NUMBER OF NAILS PER MIN.	CAP. IN POUNDS PER HR.
#00A	#16	1⅛"	700	37.2
#00	#14	1¼"	550	55
#0	#12	1¾"	450	89
#1	#10	2½"	400	192
#2	#8	3½"	325	310
#3	#4	5"	225	523
#4	#1	7"	190	622
#4s	5/16"	9"	175	1155
#5	⅜"	12"	160	2400

This high output and economical operation account for the GLADER machine being accepted as standard equipment in all recent installations.

Condon, Muncie, Indiana, assignor to The Moore Company, Muncie, Indiana, a corporation of Indiana.

Interconnection of the border frames with the marginal coil spring turns is made so each turn will be located in the plane of the border frame but will still have a certain freedom of angular movement.

✦ ✦ ✦

No. 2,217,284, ELECTRIC CABLE, patented October 8, 1940 by Robert Winstanley Lunt, London, England, assignor to Callender's Cable and Construction Company Limited, London, England, a British company.

A wire conductor is covered by a fibrous insulation, with an impervious sheath enclosing the body of insulation and a composite protective layer for the body of insulation interspersed between the surface of the conductor and the inner surface of the body, the composite protective layer comprising an inner portion consisting of an artifically formed film of semi-conductive material and an outer portion consisting of homogeneous insulating material impervious to the compound used to impregnate the dielectric.

✦ ✦ ✦

No. 2,217,337, APPARATUS FOR TREATING STRANDS, patented October 8, 1940 by Waldemar C. Ewaldson, Millington, and Heinz Kress, North Plainfield, N. J., assignors to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York.

Textile material sheathed strands of wire are treated by this apparatus with cellulose acetate and the like.

✦ ✦ ✦

No. 2,217,832, BRAID COVERED ELECTRIC CORD AND METHOD OF MAKING SUCH A CORD, patented October 15, 1940 by William T. Barrans, Towson, Md., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York.

The method comprises imparting a higher tension to the braid strands going in one direction around the cord than to the braid strands going in the other direction to incorporate the differently tensioned strands in the braid in different lengths.

✦ ✦ ✦

No. 2,217,966, COMBINED WIRE COILING BLOCK AND REEL, patented October 15, 1940 by Frank N. Perkins, Gadsden, Ala.

This device comprises a central body for receiving coils of wire and arms capable of being bent to secure the coiled wire in a compact bundle on said body.

✦ ✦ ✦

No. 2,218,138, APPARATUS FOR MANUFACTURING INSULATED WIRE OR THE LIKE, patented October 15, 1940 by John R. Stricklen, Akron, Ohio, assignor to National Rubber Machinery Company, Akron, Ohio, a corporation of Ohio.

More specifically, a new fluid-sealing connector is provided in rubber coating apparatus, whereby a splice or joint may be easily made and with little interruption of operation.

✦ ✦ ✦

No. 2,218,177, WIRE TREATING FURNACE, patented October 15, 1940 by Everton B. Powell, Maplewood, N. J., assignor to Radio Corporation of America, a corporation of Delaware.

Heated ceramic tubes are provided for heat-treating the wire, in a gaseous atmosphere, with special provision for eliminating waste of gas.

✦ ✦ ✦

No. 2,218,559, METHOD OF AND MEANS FOR KNITTING PREFORMED WIRE, patented October 22, 1940 by Frank C. Stephens, Washington, D. C., assignor to Elastic Knitted Wire Co., Inc., Providence, R. I., a corporation of Rhode Island.

This method is provided for forming a fabricated wire cylinder and consists in successively interlacing juxtaposed resilient crossed loops into a continuous interlaced spiral.

No. 2,218,560, ARTICLE OF KNITTED WIRE OR OTHER RESILIENT MATERIAL, patented October 22, 1940 by Frank C. Stephens, Washington, D. C., assignor to Elastic Knitted Wire Co., Inc., Providence, R. I., a corporation of Rhode Island.

In this patent, the article, made as above, is covered.

✦ ✦ ✦

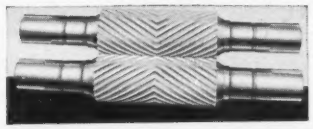
No. 2,218,979, METHOD OF MAKING ELECTRIC CABLES, patented October 22, 1940 by Armais Arutunoff, Bartlesville, Oklahoma, assignor to Reda Pump Company, Bartlesville, Oklahoma, a corporation of Delaware.

A power cable is provided by this method, having semi-cured insulating material about it, forming partitions or ribs.

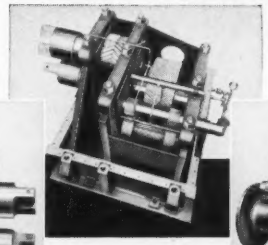
(Please turn to Page 768)

FARREL GEAR DRIVES *and* PINION STANDS

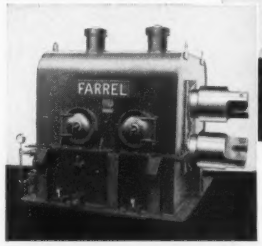
ADAPTABLE TO INDIVIDUAL OPERATING CONDITIONS

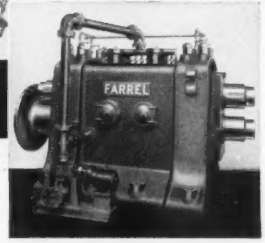


Below and Center—Two views of Double Reduction Drive and integral 20-inch Pinion Stand with welded steel case.



Above — Farrel-Sykes continuous tooth herringbone rolling mill pinions are precision generated for smooth, quiet operation.





Right — 4,000 HP Pinion Stand for four-high reversing cold strip finishing mill.

Farrel Heavy Duty Rolling Mill Drives and Pinion Stands are adaptable by design and construction to individual conditions of operation. For example, the beds may be cast steel or Meehanite or welded steel construction. Dependent upon load conditions and the requirements for rigidity a double-walled or single-walled deep base may be used. Bearings may be either plain babbitt-lined steel cartridges or any approved make of anti-friction bearing.

While gears and pinions are usually continuous-tooth herringbone, accurately generated by the Farrel-Sykes process, either single helical or a combination of single and double helical gears can be furnished. As conditions demand, lubrication may be by dip and splash system, by pump built into the unit and driven by one of the shafts, or by separate lubrication system.

The high precision with which Farrel Mill Drives and Pinion Stands are made assures smooth, quiet operation, and their rugged construction enables them to withstand the stresses, shocks and wear incident to the high speeds and heavy loads of modern mill practice.

When you have a gear problem call in a Farrel gear engineer for consultation.

FARREL

FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.

New York • Buffalo • Pittsburgh • Akron • Chicago • Los Angeles

A Review of Recent Wire Patents

(Continued from Page 767)

No. 2,219,094, WIRE DRAWING MACHINE, patented October 22, 1940 by Myles Morgan and Weld Morgan, Worcester, Mass., assignors to Morgan Construction Co., Worcester, Mass., a corporation of Massachusetts.

This machine comprises a hollow rotatable drum having a substantially cylindrical portion, a pair of spaced flanges extending outwardly from the cylindrical portion, and means to supply air under pressure to the interior of the drum, both of said flanges having apertures therein arranged to direct jets of air over the surface of the cylindrical portion from opposite directions.

✦ ✦ ✦

No. 2,219,376, METHOD OF MANUFACTURING COIL SPRINGS, patented October 29, 1940 by Leonard A. Young, Detroit, Michigan, Hubert B. Hathaway, Windsor, Ontario, Canada, and Bernard Heilman, Detroit, Michigan, said Hathaway and said Heilman assignors to said Young.

The method of forming coil springs which comprises passing steel wire stock through a heating element comprising a plurality of spaced electrodes electrically connected with a source of electrical current adapted to subject the stock to the flow of alternating electrical current of approximately 60 cycles at voltages within the range of approximately 6 to 40 volts thereby to heat the stock of temperatures within the range of approximately 475° to 575° F., thereafter passing the heated stock successively through a straightening device and forming rolls, and then forming said heated stock into coil springs.

✦ ✦ ✦

No. 2,217,162, CONDUCTOR CABLE, patented October 8, 1940 by Adriano Cavalieri Ducati, Bologna, Italy, assignor, by mesne assignments, to Transducer Corporation, New York, N. Y., a corporation of New York.

A co-axial type cable is provided, with special provision made for light weight and flexibility.

✦ ✦ ✦

No. 2,217,245, WIRE-DRAWING MACHINE, patented October 8, 1940 by Charles Arnold Barron, Preston, England.

This machine comprises a fixed receiving drum having an open end, a stationary shaft attached to the opposite end of the drum, a rotatable wire-drawing member arranged on the shaft, a stationary bearing plate for the shaft and having a wire-receiving opening, means for rotating said drawing member, and means whereby upon rotation of the drawing member wire is drawn through the member on the receiving drum.

✦ ✦ ✦

No. 2,217,276, ELECTRIC CONDUCTOR, patented October 8, 1940 by Harry Hill and Thomas Burton Rose, Belvedere, Kent, England, assignors to Callender's Cable and Construction Company Limited, London, England, a British company.

In the built up wire conductor formed, the cross sections of the component wires are such as to provide a longitudinal duct between them.

✦ ✦ ✦

New Brass Plating Process

A NEW brass plating process two to four times as fast as present processes is announced by the Electroplating Division of **E. I. duPont de Nemours & Company.** The process has been developed to provide a brass plating method which will yield smooth bright deposits of controllable thicknesses at a more rapid rate of deposition.

✦ ✦ ✦

THE process makes possible heavy deposits of brass, 0.001 of an inch or more in thickness, in a reasonable time where before heavy deposits could not be obtained at all.

✦ ✦ ✦

PREPARED High Speed Brass Salts provide a simple, quick preparation of a new bath, which will plate immediately, eliminating the "breaking in" period necessary before satisfactory results are obtained with the present processes.

Save with Syncro!

New renewable draw block tires provide greatly increased simplicity and economy.

The construction and mounting of Syncro Renewable Draw Block Tires is entirely new and different. Although the tires are securely locked in position so they cannot rotate around the blocks, they are easily changed without special tools and without brazing or lead plugging. And the tires are designed so heat expansion merely causes them to cling more closely to the blocks without distorting the tires. Moreover, any tire can be replaced at any time without disturbing the slip condition of the machine, which remains constant.

Syncro replaceable draw block tires are standard equipment on all Syncro machines except the fine wire drawing machines, and they can be installed on most existing machines of any make.

Write for complete details.

Syncro Machine Company

420 Lexington Ave., New York — McCormick Bldg., Chicago

Represented in Canada by — Canadian Elevator Equipment Co., Ltd., Toronto.

THE process operates without polarization at high anode current densities, giving proper composition and color of plate and the purity necessary to maintain the efficient operation of the bath. Addition agents prevent pitting, improve lustre and prevent objectionable fumes.

✦ ✦ ✦

THE relatively low temperature of operation, 40°—50° C. (105°—125° F.), assures ease of control and economical operation. A uniform bright yellow color may be obtained over a wide range of current densities. This means that uniform color over recessed objects is now possible. The characteristics of the deposit may be constantly maintained throughout the process by means of definite chemical control.

✦ ✦ ✦

New Laboratories for American Steel & Wire

A NEW, modern brick building to accommodate factory offices and the Cleveland district works chemical and physical laboratories of the metallurgical department will be constructed at the Cuyahoga Works, Cleveland, O., of American Steel & Wire Co., subsidiary of U. S. Steel Corporation.

✦ ✦ ✦

THE new structure will be two stories, 160 x 90 feet, and will be erected at the east end of the present Cuyahoga Works property at the 49th Street entrance near Grant Avenue.

✦ ✦ ✦

Columbium

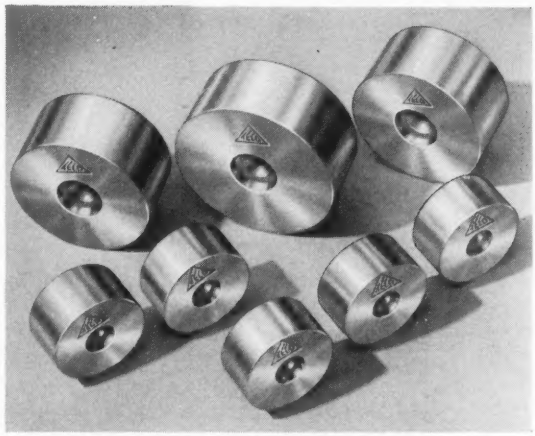
A NEW alloy, **Columbium,** a relatively unfamiliar element and with a minimum of commercial importance at present, produces an alloy of exceptional properties when added in small amounts to iron. Samples containing three per cent of columbium and the balance of iron reveal exceptionally good rupture strength at 1100 F, a temperature not yet commercially used but being approached by modern high-temperature, high-pressure steam turbines. No carbon is contained in the alloy, so it is not a steel; instead, the iron contains the columbium as a finely dispersed stable compound of iron and columbium.

✦ ✦ ✦

COLUMBIUM, an element of steel-gray color and having a bright metallic luster, was discovered in 1801. By itself the metal is malleable and ductile, and very resistant to corrosion. At one time it was used in lamp filaments, and it is used in jewelry. There is also a columbium-stabilized 18-8 (stainless) steel in which the columbium forms a carbide. The element does not occur in the free state, and its minerals are relatively rare. Only a small tonnage of columbium is produced annually, but with increased demand the supply could easily be increased. At present most of the commercial supply comes from Australia. However, it was in ore of American origin — and hence the name, columbium—that the element was first discovered.

EVEN WIRE IN TOUGH SHAPE

DRAWN SMOOTH *with*



TECO *Carbide* DIES

WIRE REJECTION CUTS into production profits, and raises hob with rush-production schedules. Most of this troublesome expense you can avoid by using Teco Carbide Wire Dies. Teco Dies reduce wire rejection to a minimum. Scratched and out of round wire, for example, can be drawn smooth through Teco Dies.

This is just one of many ways in which diamond-hard Teco Carbide Dies cut wire drawing costs and save production time. More wire tonnage per die, finer finished wire, longer lasting dies with fewer replacements, less time lost in recutting — you get them all when you specify Teco Carbide Wire Dies.

Investigate today. A Tungsten Electric engineer will be glad to discuss your wire drawing problems with you and show you in your own plant how Teco Dies lower wire drawing costs and increase production. Consult us.

Pioneers in Tungsten Carbides for more than a Quarter of a Century

Never Say Die—always specify
TECO CARBIDE DIES
for *smooth* wire drawing--they last longer!

Tungsten Electric supplies carbide blanks, tools and bits. Wire and bar dies, tubing, extruding and sizing dies. Also, special tools, such as spot facers, reamers, broaches, form tools, etc.

TUNGSTEN ELECTRIC CORPORATION
564 – 39th ST. • UNION CITY, N. J.
Branch Office: 2900 Euclid Ave., Cleveland, O.

New Extrusion Press

Now Permits Extrusion of Stainless Steel, Ferrous and Non-Ferrous Tubing and Rods

WHILE the extrusion of non-ferrous metals has been performed for 35 years, it is only during the past several years that the extrusion process has been successfully employed for the production of stainless steel, nickel alloy and ferrous rods, tubing and shapes. This advance, which appears likely to open new fields for special alloys, has been made possible by the development of the hydraulic extrusion press. A press of this type, of 2000-tons capacity, built by Farrel-Birmingham Company, Inc., of Ansonia, Connecticut, is shown in the accompanying illustration.

✦ ✦ ✦

THE designers believe that with this new press, all of the currently known stainless steels and other special ferrous and non-ferrous alloys, which do not work well by rolling, welding or piercing, can be extruded without difficulty.

THE advantages of extrusion over rolling and drawing are well known. It is probably correct to say that any article which has been extruded from a billet has acquired a grain structure more free from faults than if it had been rolled. This change in structure is due to the fact that extrusion is a squeezing-compression process, while rolling and drawing is a stretching operation. There are many special alloys which cannot be successfully rolled at all without developing serious inherent faults which render them unfit for certain commercial purposes.

✦ ✦ ✦

Larger Reduction Obtainable From Extruded Tubes

ANOTHER advantage of the extrusion process is that extruded tubes of stainless steel, for instance, can be far more easily drawn down to smaller sizes than tubes manufactured by any other process. This means that a larger reduction can be obtained from extruded tubes than from tubes made on a piercing mill. For example, it is possible to draw down extruded tubes to a final dimension of a few thousandths of an inch in diameter, such as are used for hypodermic needles, the final tubes having a perfect structure. This was not possible formerly, when the original tubes were produced by a piercing mill. Extruded tubes possess a first-class structure and in general are of a far higher quality than tubes manufactured by any other method.

✦ ✦ ✦

WITH the new extrusion press aluminum alloys are extruded in numerous semi-finished shapes which are much more readily worked into final dimensions than if they have gone through the older mill processes.

✦ ✦ ✦

Only Clean Material Extruded by The New Press

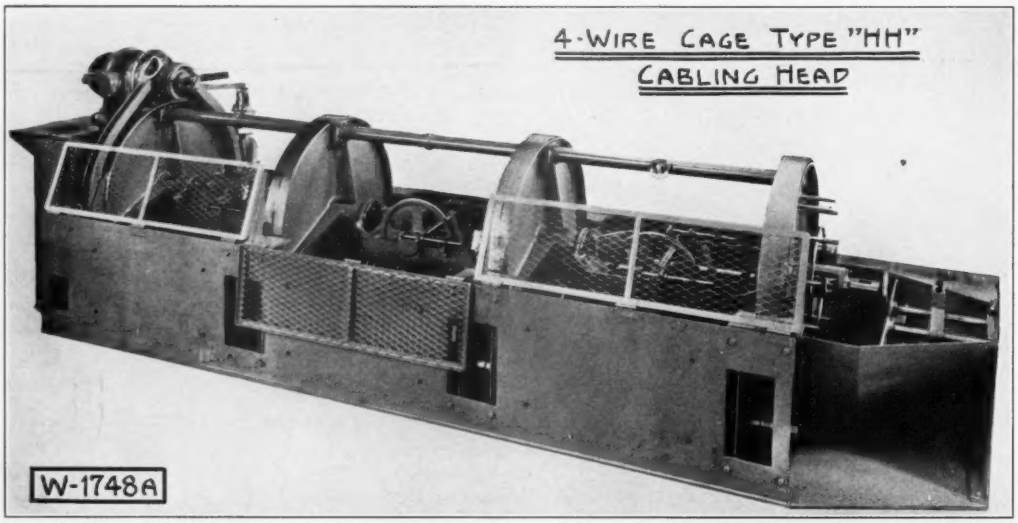
THE billets to be extruded by this press can be taken as rough cast billets coming from the foundry after being cut to the

THE WATSON MACHINE COMPANY

ESTABLISHED 1845

PATERSON, NEW JERSEY, U. S. A.

HIGHEST MACHINE SPEEDS



16", 24", 30" & 40" SPOOL SIZES

proper length. The skin of the billets, which is formed mostly by oxidation, remains as a thin shell in the container after extrusion, so the extruded product is formed of clean material only. This is particularly important in the manufacture of high-quality products.

✦ ✦ ✦

TUBES and rods manufactured by this press are not only remarkably sound in structure but possess excellent metallurgical and physical properties and a good condition of surface. Consequently the number of draws for finishing can be considerably reduced.

✦ ✦ ✦

THE amount of scrap—consisting of the thin shell of the billet and the discard—is very low, so the difference in weight of the billets charged into the container and of the extruded product is only about 8% to 10% in the case of tubes, and about 10% to 12% when manufacturing rods. The concentricity of the extruded tubes is well within the commercial limits, and provided that sound billets, uniformly heated, are extruded, it will be within plus or minus 5% of the wall thickness. Compare with this the tolerance in wall thickness usually expected by manufacturers of steel tubing not produced by the extrusion process, which runs as high as 10% to 12%.

✦ ✦ ✦

Personnel Changes in American Steel & Wire Operating Dept.

WILLIAM F. CONLIN, division metallurgist, American Steel & Wire Co., Cleveland, has been appointed open-hearth superintendent at the steelworks in Donora, Pa. **John A. Slenker**, open-hearth superintendent at Donora, has been transferred to Cleveland as a division metallurgist. **Henry R. Patterson**, assistant general superintendent, Donora Steel & Wire Works, has been transferred to Cleveland as engineer of wire drawing development, while **A. F. Ilacqua** has been named division metallurgist on high carbon steels at Cleveland.

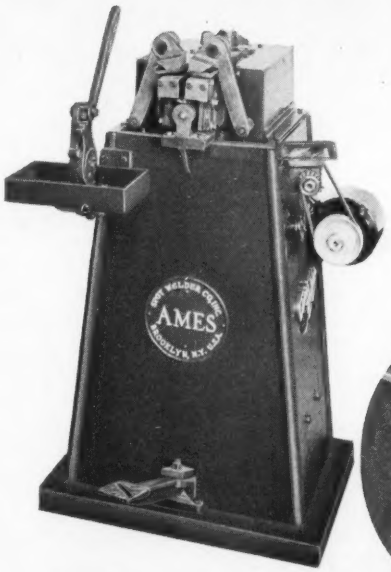
✦ ✦ ✦

Norman H. Wright, Sales Representative, Torrington Mfg. Company

THE Torrington Manufacturing Company announces with pleasure the appointment of **Norman H. Wright**, 25 Irvington Street, Boston, Massachusetts, as exclusive sales representative in New England.

✦ ✦ ✦

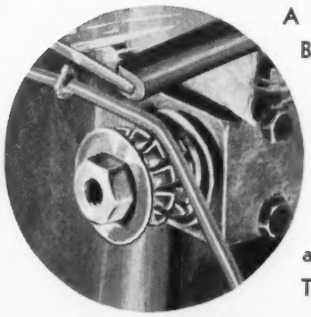
MR. WRIGHT succeeds the late **P. M. Patterson** with whom he had been associated for some time after a period of specialized training in the Torrington laboratory and shop.



AMES BUTT WELDER

IB

INTRODUCING TO THE WIRE TRADE



BURR REMOVER
PATENTED

A Combination Butt Welder Cutter and Burr Remover with new and distinct Time Saving Features.

Perfecting the art of removing the burrs from welded wire rods with new burr removing device. Cutters, that furnish clean cut rivet ends for stronger welds, all conveniently located and heat control on top of welder.

A sturdy, well built, and compact machine for Wire Mills where speed, control, and ease of operation is essential.

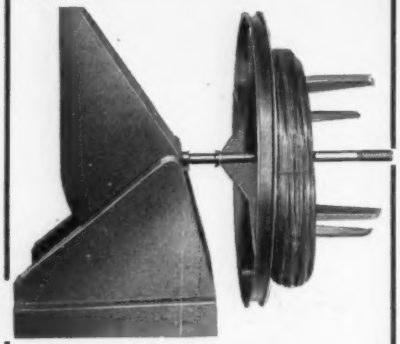
Carefully engineered and performance proven. Protected by American & Canadian Patents.

IGOE BROTHERS, INC.

AVE. A. & POINIER STREET NEWARK, N. J.

THE "SHIFTWEIGHT" TILTING WIRE REEL

A counter-balanced tilting wire reel with full 42" diameter upper guard rings, allowing perfect feeding of wire off the coil and absolutely "Snarl Proof."



Weight so distributed that reel need not be bolted to floor.

Moslo Machinery Inc.

5005 Euclid Ave.
Cleveland Ohio

Wire Reels Rod Bakers
Spot Welders Roll Straighteners
Wire Straightening and Cutting
Machines

C. L. Allen, Chairman of the Board, The Norton Company

CHARLES L. ALLEN, 82, dean of Worcester industrialists, chairman of the board of Norton Company and its general manager for 48 years, until his retirement from that position in 1933, died November 4th, 1940, of bronchial pneumonia.

✦ ✦ ✦

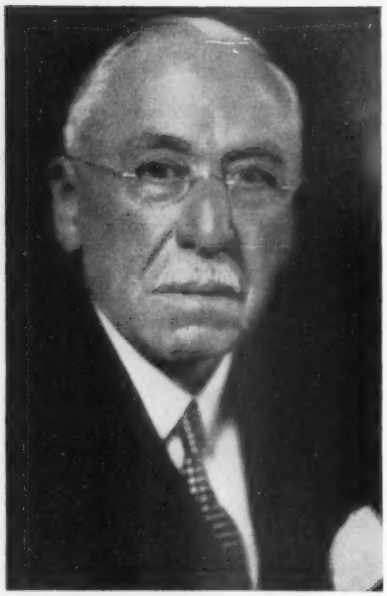
MR. ALLEN started with the Norton Company as a bookkeeper in 1881 when the company was a struggling pottery shop employing only thirteen men and where an experiment in making a grinding wheel eventually lead to the vast factory in Greendale.

✦ ✦ ✦

THE Norton Emery Wheel Company was organized in 1885 and he was made its general manager until 1933. However, he became secretary and director of the company in 1892 and in July, 1912, its treasurer.

✦ ✦ ✦

IN 1919 when the Norton Emery Wheel Company and the Norton



C. L. ALLEN
Chairman of the Board
The Norton Co.

Grinding Company were merged as the Norton Company Mr. Allen was elected President and general manager of the new Norton Company.

✦ ✦ ✦

HE was also on the Directorate of the Riley Stoker Corp., the Worcester Manufacturers Mutual Insurance Co., Liberty Mutual Insurance Co. of Boston, and the Junior Achievement, Inc., of Springfield. He was also chairman of the board of the Indian Hill Company and a trustee of the Worcester Five Cents Savings Bank.

✦ ✦ ✦

Donald R. G. Cowan, Manager of Commercial Research, Republic Steel Corporation

THE appointment of **Donald R. G. Cowan** as Manager of Commercial Research of Republic Steel Corporation has been announced.

✦ ✦ ✦

MR. COWAN was chief statistician of the research department of Swift & Company of Chicago. He is a Canadian and graduated from Queen's University in 1917, where he won the Sir James Cowan prize in political science. He received his M.A. degree from the University of Toronto in 1918, and remained there for two years under a fellowship in political economy. He took graduate courses at University of Minnesota, University of Chicago and Northwestern University, and received his Ph.D. degrees from the University of Minnesota in 1934, majoring in economics.

✦ ✦ ✦

STUDIES by Cowan have appeared in numerous business publications and he is the author of a book entitled "Sales Analysis from the Management Standpoint".

✦ ✦ ✦

COWAN'S work for Republic Steel Corp. will continue to be along lines of market research and analysis. His office will be in the Republic Building, Cleveland.

✦ ✦ ✦

R. A. Karr, Metallurgist, Copperweld Steel Co.

R. A. KARR has been appointed metallurgist, Copperweld Steel Co., Warren, O. He formerly was associated with Battelle Memorial Institute, Columbus, O., and later with Central Alloy division of Republic Steel Corp.

✦ ✦ ✦

L. R. Ludwig, Manager, Switchgear Division, Westinghouse Elec. & Mfg. Co.

LEON R. LUDWIG has been appointed manager of two newly combined sections of Westinghouse Electric & Mfg. Co.'s switchgear division at East Pittsburgh, Pa. Mr. Ludwig, heretofore manager of protective devices engineering the past five years, will head the combined division of circuit breaker and protective devices engineering.

✦ ✦ ✦

J. A. Ingwersen, Mgr., Sheet & Strip Sales Div., American Rolling Mill Co.

J. A. INGWERSEN has been named manager of the sheet and strip sales division of American Rolling Mill Co., Middletown, Ohio, and **F. E. Wortley** has been promoted to the position of manager of Midwestern sales, succeeding Mr. Ingwersen. Both men have had wide experience in sales work. Mr. Ingwersen has been connected with Armco's sales division for 15 years and Mr. Wortley's sales connection dates to 1912.

Birmingham's leading technical institute, Goudielock began his experiments as the result of just such a tin shortage confronting British naval construction as it does today.

✦ ✦ ✦

IT was found also that the new metal produced with the hardener had the additional advantage of coming out of casting with a clean surface, and it is available for fabrication by either the wrought or cast methods of production.

✦ ✦ ✦

Safety Tongs

EQUIPMENT that will improve efficiency and speed and also aid in eliminating employee accidents should prove of interest to every industrial executive or works manager. In plants where materials have to be handled by cranes or hoists, which includes practically every industry, the use of Gellert Tongs, now produced exclusively by Heppenstall Company, of Pittsburgh, are said to decrease hazards to life and limb, and to cut lost time to a minimum.

✦ ✦ ✦

ALL that is required with Gellert Tongs is to lower the tongs on to the work, and the tongs do their job automatically. The craneman has entire control, and ground men do not have to throw chains around hot ingots or forgings, nor climb to the top of scrap piles with danger of slipping or being crushed by material rolling down.

✦ ✦ ✦

SEVERAL types of these tongs are in successful operation in steel mills and foundries for handling ingots, **ingot molds, die blocks, pipe, and wire**; and other special designs are made for non-ferrous metal ingots or shapes, paper bales, sacks of sugar and similar materials. Lifting capacities run as high as 200,000 pounds.

✦ ✦ ✦

TO assure freedom from failure and long operating life, the working parts of these tongs are made of a nickel-chromium-molybdenum steel corresponding to S. A. E. 4340, heat treated to provide ample strength along with toughness to resist shock loads.

Standard Swagers

Available in a complete range of sizes for handling solid stock from ⅛" to 3¾" diameter!

Widely used for every need from pointing wire ends to swaging connections to cable, conduit and hose.

What is your swaging job?

Write for 20 page Catalog SM.

IT'S STANDARD PRACTICE

MACHINERY COMPANY

PROVIDENCE, RHODE ISLAND

For BETTER WIRE

Copper-coat with CUPRODINE

CUPRODINE creates a denser, tighter, brighter and more uniform coating, in less time. Provides better lubrication for drawing than ordinary copper coating.

Pickle with RODINE

RODINE, added to the pickling bath, saves acid and metal, minimizes brittleness, and lowers pickling costs. Standard the world around.

CHEMICALS ACP PROCESSES

For complete information write Dept. 306

AMERICAN CHEMICAL PAINT CO.

Main Office and Works Ambler, Pennsylvania

Strength!

Clark Cable and Insulated Wire Spools provide strength and rigidity for the most difficult wire and solder winding operations.

This rugged construction is easy to assemble, reducing over-all costs of operation.

A simple hand arbor, foot or power press operation permanently assembles heads and barrels. All parts are lithographed for identification purposes and to protect the metal.

SPECIFICATIONS

HEAD DIAMETERS —5, 6½", and 10½"
BARREL DIAMETERS—1⅛", and 3½" (special diameter for 10½" head)
BARREL LENGTHS —To meet your capacity needs

J. L. CLARK MANUFACTURING CO.
600 23rd Avenue Rockford, Illinois

REACTIVE WIRE DRAWING

CHANGE YOUR WIRE MILL OVER

INSTALL:—

PROPORTIONAL PRESTRESSING UNITS on your Morgan-Connor and Vaughn machines.

These Units may be applied to any existing wire drawing machine of the non-slip type, or to any single block machines.

ADDRESS

REACTIVE WIRE DRAWING

P. O. Box No. 279 Worcester, Mass.

Low Cost Finishing Process Permits Use of Drawing Dies For Short Runs

DEVELOPMENT of a complete line of equipment for finishing and servicing of Carboloy drawing dies for producing special shapes of bar and rod—such as hexagonal, square, rectangular, half-round, etc., is announced by **Carboloy Company, Inc.**

✦ ✦ ✦

THE new equipment is being made available directly to users enabling them to employ such dies economically for short as well as long runs and in numerous types of special shapes.

✦ ✦ ✦

COINCIDENT with the announcement, Carboloy is offering shape dies in low-priced cored or pre-formed state for rapid finishing to shape desired by the user, through use of the new equipment. The line comprises standard hexagon and square rough cored dies available in a wide range of sizes, covering all common requirements of industry. These dies are so designed as to require a minimum of stock removal for finishing to the usual sizes, the cored shapes being virtually identical to the usual forms of drawing dies—with a sixteen degree approach angle and a 30 degree back relief angle.

✦ ✦ ✦

ESSENTIALLY the equipment consists of a die-bearing sizing machine, a die shaping machine, a hand polishing tool and an adaptation of a bench shaper for machining the required laps.

✦ ✦ ✦

RECOMMENDED for use with this equipment are laps of mild steel, to be used in a combination with various grades of boron carbide or diamond powder as lapping compounds for roughing and finishing the dies.

✦ ✦ ✦

ALL three of the simple machines designed for working the dies have the same basic action—a short high speed reciprocating stroke. In all cases an electric motor drive actuates an eccentric which in turn imparts a reciprocating motion to the vertical spindle.

TO rough and finish the bearing of the dies, laps of the same shape as the bearing, but with .010 inch taper, are used, the number of laps required depending on the number of times .010 in. of stock has to be removed to finish the bearing of the die.

✦ ✦ ✦

LAPS for producing entrance, approach, bell and back relief angles also are of the same shape as the cross-sections they are to produce, but are smaller in size. In lapping the angles, the lap is reciprocated by the vertical spindle. At the same time, die and spindle are rotated slowly by hand. Spring tension maintains a uniform pressure of the lap against the portion of the die at the rear of the machine, so that—as the die is rotated, all faces and corners, are lapped in turn.

✦ ✦ ✦

Finishing Equipment for Shape Dies introduced by Carboloy Co., Inc. At left, angle-lapping machine; center, bearing finishing machine; right, shaper for machining of laps. Next to the shaper is the electric hand finishing tool for finish polishing of the dies.

✦ ✦ ✦

THE finishing or polishing hand tool also employs laps, reciprocated at high speed through an electric motor driven eccentric with a short stroke—about ⅛ inch. The tool is used mainly for polishing the surfaces.

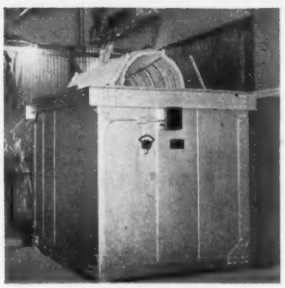
✦ ✦ ✦

A SPECIAL adaptation of an Atlas bench shaper has been worked out for machining the laps. The swivel plate on this shaper is mounted at an angle so that in the normal position a .010 inch taper is produced on the laps being shaped. Furthermore, in shaping, the swivel plate is set over at a 5° angle to the stroke so that the feed marks will be at an angle to the axis of the lap, which—when combined with the use of lapping compound—produces a filing action on the die.

✦ ✦ ✦

TO machine angle laps, the work is mounted in a collet and the tilting dividing head is set at an

(*Please turn to Page 776*)



CARL-MAYER HI-SPEED ROD BAKER

Patents Pending

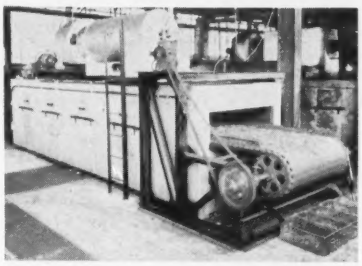
Results of first installation bring second order for Carl-Mayer HI-SPEED Indirect Pit Type Rod Baker from prominent Steel Company of Canada. Check these production figures:

Baker Temperature, 500°F. Load per Pin, 2100 lbs.

LOW CARBON, .15-.20				HI-CARBON, .4-.7			
7	Minutes	per	pin	9	Minutes	per	pin
7	"	"	"	10	"	"	"
6	"	"	"	11	"	"	"
8	"	"	"	10	"	"	"
6	"	"	"	9	"	"	"

PLUS 50% FUEL REDUCTION Write for complete data.

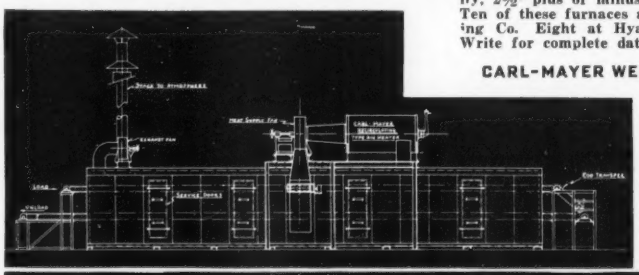
CARL-MAYER FURNACES, ROD BAKERS WELDING ROD OVENS



CARL-MAYER AIR DRAW FURNACE

Up to 70% savings plus temperature uniformity, 2½° plus or minus. Air heater principle. Ten of these furnaces at Timken Roller Bearing Co. Eight at Hyatt Roller Bearing Co. Write for complete data.

CARL-MAYER WELDING ROD OVEN



As built for the Page Steel & Wire Co. and Hallup Corp. for drying coated alloy welding rods, using the "Mayer" recirculating gas fired air heater principle. Write for complete data.

OVER 20 YEARS EXPERIENCE

The CARL-MAYER Corp.
3030 Euclid Ave., CLEVELAND, OHIO.

W. D. Coolidge and S. M. Crocker Appointed G. E. Vice Presidents

THE appointment of **Dr. W. D. Coolidge** and **Stuart M. Crocker** as new General Electric vice president has been announced by Charles E. Wilson, president of the company.

✦ ✦ ✦

DR. COOLIDGE will continue as director of the General Electric Research Laboratory in Schenectady. Mr. Crocker will relinquish his duties as manager of the company's air conditioning and commercial refrigeration department at Bloomfield, N. J., to make his headquarters in New York City where he will cooperate with and be assisted by all commercial departments in furthering the general interests of the company.

✦ ✦ ✦

NOTED for his own achievements with X-ray tubes, ductile tungsten and submarine detectors, Dr. Coolidge has been a member of the research laboratory staff since 1905 and director since 1932. He is a member of the National Inventor's Council recently created to encourage civilian inventions as part of the national defense program.

✦ ✦ ✦

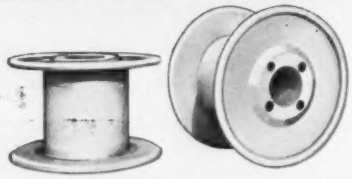
MR. CROCKER has been manager of the air conditioning and commercial refrigeration department since May 1939, and a vice president of the International General Electric Company since 1930. His career with General Electric dates from 1921 when, after working in the traffic and sales departments of the Radio Corporation of America, he became assistant to Owen D. Young, than chairman of the boards of both R. C. A. and General Electric.

✦ ✦ ✦

Harvey L. Miller, District Manager Wheeling Steel Corp. At Houston, Texas

HARVEY L. MILLER has been named manager of the district office recently established by Wheeling Steel Corp., Wheeling, W. Va., at 2508 Gulf Building, Houston, Tex. **I. G. Thompson** continues as district sales manager at Dallas, Tex.

APCO MOSSBERG
STEEL REELS & SPOOLS



For The Copper, Steel, & Wire Rope Industry

Apco Mossberg Steel Reels are standard equipment in the wire industry—and for good reason! Apco Mossberg—the original Frank Mossberg Co.—**originated** the steel reel idea and have been training workmen in their manufacture ever since. Personal attention by Apco Mossberg engineers make each job a "special".

FREE ENGINEERING SERVICE

We will gladly submit drawings, blueprints, or suggestions without obligation to you. Write for quotation today.

APCO MOSSBERG CO.
(The Original Frank Mossberg Co.)
21 Lamb Street, Attleboro, Mass.

Better Drawing with MAGNUS DRY WIRE LUBRICANTS

Magnus Dry Wire Lubricants are finely divided and anhydrous to provide the best and most uniform coating. Their dryness and fineness allow a "rolling action" of the lubricant in the die box ensuring continuous contact with and even coating of the wire.
They give materially increased tonnage per pound of drawing compound used.
There is a type for every kind of wire and drawing operation.

GET THIS PERFORMANCE DATA

Ask for performance data from wire mills covering their experience with Magnus Wire Drawing Soaps and Greases.

MAGNUS CHEMICAL CO.
188 South Ave., Garwood, N. J.
Magnus CLEANERS

Low Cost Die Finishing Process

(*Continued from Page 775*)

angle corresponding to the angle of the die the lap is to finish. A protractor scale is provided on the tilting dividing head for this purpose.

✦ ✦ ✦

TO finish a die with this equipment, the die is first placed in the bearing sizing machine, lapped to within .010 inches of finished size with 100 grain boron-carbide, and to .005 in. of size with 220 grain boron-carbide.

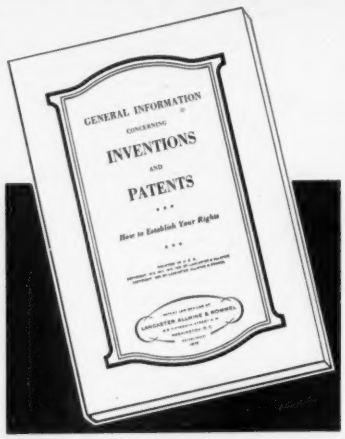
✦ ✦ ✦

IT is then placed on the die shaping machine and the various angles are rough lapped with 220 boron carbide. The bearing is then semi-finish lapped on the sizing machine to .002 in. using #5 diamond powder. The profile is next blended with the hand tool, using #5 diamond powder. The bearing is next lapped to .0001 inch of size on the sizing machine, using #6 diamond powder and then finished with a wood lap using the same diamond powder. Alternately with this final operation, the hand tool is used to re-blend and re-polish the profile of the die, using #6 diamond powder.

✦ ✦ ✦

Metallurgy Contributes to Betterment of Phosphor-Bronze Springs

RESEARCH has made today's phosphor-bronze springs, so important in so many types of electric equipment, far superior to those of yesterday, said Dr. R. H. Harrington and R. G. Thompson of the General Electric laboratories in addressing the American Society for Metals, in Cleveland October 23. A newly developed heat treatment has increased their electrical conductivity; and their elastic limit, proportional limit, elongation, and fatigue properties have been advantageously affected, the men reported. The result is that phosphor-bronze springs now have a much longer life, and applications additional to those of years back.



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No charges are made for preliminary advice, either in connection with patent, trade-mark or copyright cases.

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438 Bowen Bldg., Washington, D. C.

INCREASE LIFE OF YOUR DIES with *NEW* NOPCO SOAPS!

FOLLOW the lead of many of the country's largest steel wire mills. Increase the life of your dies by using Nopco "99" improved dry soaps.

In addition to longer life, you will find these 99% active dry soaps eliminate periodic die trouble formerly caused by faulty lubrication . . . result in a better wire finish . . . and give higher yields per pound of soap.

Nopco "99" soaps are available in three types—PX, LX and NX—for both high and low carbon wire and rod.

JUST ONE TRIAL WILL CONVINCE YOU!
Write Today!

NOPCO
BOSTON CHICAGO
CEDARTOWN, GA. LOS ANGELES
NATIONAL OIL PRODUCTS CO.
HARRISON, NEW JERSEY

PHOSPHOR-BRONZE—an alloy of copper with a varying amount of tin and a slight trace (0.1 to 0.2 per cent) phosphorus—has properties making it ideally suited for various electrical applications. It is nonmagnetic, so can be used in many cases where steel is out of question, and its corrosion resistance is better than that of the usual spring steel. It can be drilled, stamped, and otherwise machined without necessity of heat treatment, and can be soldered or brazed with ease. The electrical and physical properties vary with the tin content—the higher the tin content, the lower the conductivity and the harder the alloy.

✦ ✦ ✦

PHOSPHOR-BRONZE springs are cold rolled, and the rolling causes the crystals in the alloy to become elongated in the direction of rolling. There is a temperature, varying with the composition of the cold-rolled bronze and the amount of cold reduction, at which recrystallization occurs. The alloy then regains the type of structure it had before it was rolled—and lacking the properties the electrical engineer requires. By heating the bronze for a long period of time below this recrystallization temperature, there occurs a precipitation reaction which prevents or hinders such recrystallization. The treatment improves not only the electrical conductivity of the alloy, but also its resistance to fatigue, its proportional and elastic limits, and its elongation and fabrication properties.

✦ ✦ ✦

THE laboratory investigations indicate, the men reported, that the same principles of treatment can be applied with beneficial results to all strained solid-solution alloys, of which phosphor bronze is but one example.

✦ ✦ ✦

Insulated Wire For Chemical Industries

NEW types of insulated electrical cables for use in the chemical and other industries where cables are exposed to corrosion, moisture, solvents, or greases, have been developed by the Siemens Werke, Berlin, according to the Fats and Soap Journal. For wiring telephones in chemical factories, the wires are insulated with silk and coated with synthetic resin which makes them moistureproof and almost noninflammable. So-called "Protodur" wires, insulated with a polyvinylic chloride plastic, are claimed to be acid and oil proof and noninflammable. They are used for wiring electrical appliances and for use under plaster. These cables are especially smooth and nearly frictionless, as no protective plating is placed around the molded insulation, which is reported to show a high resistance against aging.

✦ ✦ ✦

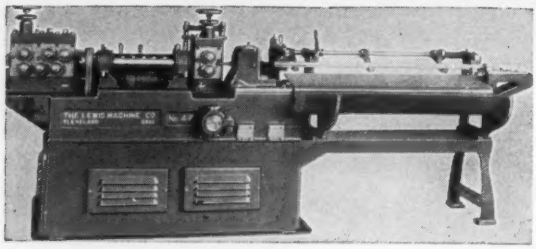
ANOTHER type of insulation developed by Siemens, "Parnit," is a soft, flexible rubber substitute. "Parnit" cables are delivered also with an armoring of folded and finely corrugated metal. A further type of novel insulated cables for special purposes brought out by the German company is the "Protolit" cable, the ceramic insulation of which makes it especially suitable for heating purposes.

"STANDARD WIRE DRAW"
FOR HIGH-LOW CARBON, BRIGHT, COLD HEADING
WET WIRE DRAWING
● Lower die costs ● Better finished wire
● Lubricants specially adapted for drawing on high speed machines
EXPERIENCED SERVICE MEN WILL DEMONSTRATE THE MERIT OF OUR PRODUCTS
STANDARD INDUSTRIAL COMPOUNDS CO.
4600 Ferdinand St. Chicago, Ill.

Learn about PARALAN
Paralan will give your finished wire and wire products protection from atmospheric corrosion in the mill and in shipping. Paralan-coated wire can be spot welded or soldered without cleaning. Also, Paralan leaves surfaces in good condition for all types of finishes—enameling, japanning, lacquering, plating, etc.
Write for further information. We may be able to solve your difficulties.
AMERICAN LANOLIN CORP.
LAWRENCE, MASSACHUSETTS

WIRE INSULATING, STRANDING AND CABLING MACHINERY
NEW ENGLAND BUTT COMPANY
Office and Factory
304 Pearl St., Providence, R. I.
Western Office
20 North Wacker Drive, Chicago, Ill.
We build a complete line of Stranding Machines, Cabling Machines, Closing Machines, Rubber Strip Covering Machines, Measuring Machines, and Other Allied Machines for the Wire Trade.
OUR WIRE MACHINERY CATALOGUE SENT ON REQUEST

LEWIS TRAVEL-CUT WIRE STRAIGHTENING and CUTTING Machines



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Flat
Hexagon

Ferrous and Non-Ferrous

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High Speed
Heavy Duty

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Catalog - Calendar
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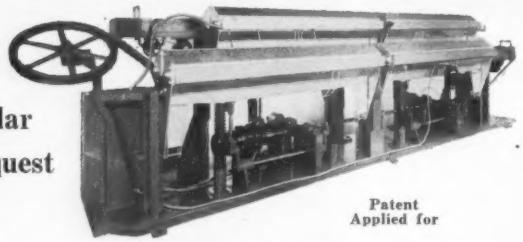

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For Details Address
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Notes on the 1940 Convention

CRITICISM of a technical meeting falls naturally into two divisions; the writer's personal views, and opinions overheard in the lobbies and the Association headquarters. By both criteria the meeting just closed was rather more satisfactory than those of recent years.

+ + +

IN the writer's view there was a better balance between papers of broad interest and those of a narrower and more highly technical field, which made for better attendance and discussion. Mixing the ferrous and non-ferrous papers tended to interest those two branches in one another's problems.

+ + +

OPINIONS picked up outside the meeting rooms were many and interesting, and rather generally expressed satisfaction in the trend. Some rather vigorous but constructive criticism was heard, of which a summary runs somewhat like this:

+ + +

WE have never had such good meetings as we conducted in 1932 and 1933, the first of the "discussion" sessions. We have too many technical papers which are hard for the average operating man to digest, understand and discuss from the floor. We need more discussions of everyday problems such as are common to the experience of all.

+ + +

THERE is much validity to this criticism. The answer is that in those early days we had not yet talked out the simpler problems. Now we all know each other better, and know each other's practices and opinions, and tend more strongly toward uniformity. It is harder to provoke a discussion over the simpler problems because there is less and less difference of opinion and of practice as time passes. Still the criticism stands, and it is up to the program committee to plow the ground again and again.

+ + +

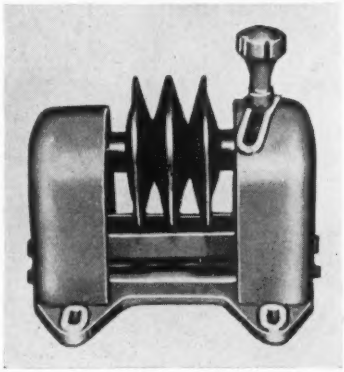
REGARDING technical papers, interesting to fewer members, but deeply interesting to those few, this criticism was heard. Discus-

sion is not as fruitful as it might be. The delay incident to getting names to the reporter takes the edge off enthusiasm. A man who has valuable ideas to contribute may not be fluent in debate, or clear in his enunciation, and his thoughtful comments may be entirely lost, or be practically nullified by contrary opinions which are ill-founded but rather neatly expressed in an assured manner and a clear voice, of which the reporter gets every syllable. This is a valid complaint. In the past eight years we have all seen economic and political heresies slipped over on the public by slick timing, stage-setting, and vocalizing and there is no sense in carrying the system over into our business.

✦ ✦ ✦

News About the All-Speed Variable Speed Transmission

A NEW V belt variable speed transmission, known as the ALL-SPEED, is being introduced to industry by the **Standard Transmission Equipment Company** of Suite 330, 416 W. 8th St., Los Angeles. The speed selector operates on the variable pulley principle, and consists of two interlocking pulleys mounted on a common shaft. The variable speed spindle can be pivoted laterally between the motor and the driven machine to provide new running diameters on the interlocking pulleys. The selected speed is maintained by means of a lock nut on the control quadrant, and the oblique slot which automatically and positively guides the spindle at all times insures perfect belt alignment and increases belt life.



This is a distinctive feature of the ALL-SPEED Variable Speed Transmission which is especially advantageous when control unit is mounted vertically as is often necessary in certain applications such as drill press mountings, etc. Special impregnated bronze bearings are used with forced lubrication provided at all times. The ALL-SPEED is the result of considerable experience in the varipitch pulley field, and it is especially designed for applications where speed selection is vital to production, but where cost is a large factor. In keeping with this aim, the ALL-SPEED combines attractive design durable construction, wide speed range, efficient and proven principle of operation, and very low cost. The ALL-SPEED is made in three sizes for ⅜", "A," and "B" belts, and in speed ranges up to 12-1. Descriptive data available on request.

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From all quarters has come commendation of this latest ASM book on practical metallurgy. Already four famous engineering schools—Case School of Applied Science . . . University of Wisconsin . . . Brooklyn Polytechnic Institute . . . Stevens Institute of Technology — are planning to use this book as a textbook for their courses in metallurgy.

Typical of other responses is that from Dr. Zay Jeffries, General Electric authority, who says: "The book constitutes a valuable addition to the literature of metallurgy".

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Applied Physical Metallurgy — Industrial Processing of Ferrous and Nonferrous Metals and Alloys
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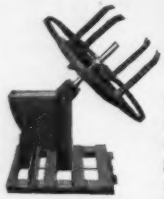

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With
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✦ ✦ ✦

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Leading manufacturers of
OVERHEAD MATERIALS HANDLING EQUIPMENT
for the Wire and Wire Products Industry

Institution of Automobile Engineers Awards for Session 1939-40

AT the last Meeting of the Council of The Institution of Automobile Engineers the awards for the Session 1939-40 were decided upon, as follows:—

The Crompton Medal—For the best paper read before the Senior Centres of the Institution during the Session—
To Dr. J. S. Clarke (Birmingham Corporation Gas Dept.) for his paper entitled "The Use of Gas as a Fuel for Motor Vehicles".

✦ ✦ ✦

The Graduates Prize—For the best papers read before the Graduates' Section during the Session—
Second Prize (value £8.) to Mr. J. F. Norwood (Luton Branch) for his paper entitled "Gear Tooth Profiles".
Third Prize (value £5.) to Mr. F. W. Judd (London Branch) for his paper entitled "The Trend in the Development of the Compression-Ignition Engine".
(Note. The First Graduates Prize was not awarded.)

✦ ✦ ✦

New D. C. Crane Limit Stop

CUTLER-HAMMER, INC., Milwaukee, Wisconsin, manufacturers of Motor Control, Safety Switches and allied electrical equipment announces a new type main circuit crane safety limit stop to prevent overtravel of the crane hook when hoisting.

✦ ✦ ✦

THE new device operates by means of a counter weighted lever and a suspended reset weight. As the hook approaches its limit of travel the reset weight is raised thus allowing the counter weight to trip the switch. A quick make and break mechanism opens the normally closed power contacts to disconnect the motor from the line and closes another set of contacts to connect a resistor across the motor circuit establishing smooth, quick. dynamic braking. Taps are provided in the resistor to adjust the braking in accordance with the service condition. When the limit stop is in the tripped position, a by-pass circuit is established which

GEORGE D. HARTLEY

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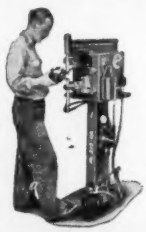

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permits backing out of the limit at slow speed.

✦ ✦ ✦

AMONG the outstanding features of the new switch are: quick make and quick break tripping mechanism; completely enclosed case withstands rain, snow, ice and dirt; neoprene gasket makes switch waterproof for outdoor installations; (not true in one quadrant); the limit stop may be mounted in any of four quadrants; ball or needle bearing throughout with provision for greasing; standard contactor parts and blowouts are used throughout; flexible leads brought out through bushings in the case with lugs for external connecting. Rating 100 HP at 230 Volts D.C.

✦ ✦ ✦

Glycerine Aid in Metal Cleaning

AMONG the practical and effective methods and materials for removing rust, forge scale and dirt from iron, steel and sheet metal presented by **R. Plucker** in the technical publication, **"Emaillwaren-Industrie,"** glycerine is an important constituent or adjuvant.

✦ ✦ ✦

AN inexpensive solution for removing rust is made of:

Sodium hydroxide	**750 Gm.**
Soda crystals	**875 Gm.**
Potassium permanganate or potassium manganate	**10 Gm.**
Water	**12 liters**

For cleaning off dirt, oil, colors and the like, the addition of a little glycerine to the solution is recommended.

✦ ✦ ✦

SINCE they keep well, the mixed dry materials may be stored and added to the water just prior to use. The rust dissolves after a few minutes in the solution and can be wiped off. The metal underneath is not corroded and possesses a thin coating which protects it from rust for a short time. The glycerine addition does not affect the derusting action.

✦ ✦ ✦

FOR metal cleaning alone, the following glycerine-containing mixture is advocated:

Soda crystals	**4 Kg.**
Sodium hydroxide	**250 Gm.**
Glycerine	**125 Gm.**
Potassium manganate	**16 Gm.**
Hot water	**120 liters**

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In rolls of any size for wrapping coils and reels.
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Hubbard Spool Co., Chicago, Ill.
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Vaughn Machinery Co., Cuyahoga Falls, O.

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National Oil Products Co., Harrison, N. J.

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Farrel-Birmingham Co., Ansonia, Conn.
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

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Rusch Wire Die Corp., New York, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Works, New York, N. Y.

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Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Tungsten Electric Corp., Union City, N. J.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Works, New York, N. Y.

DRAW BENCHES—
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Standard Machinery Co., Providence, R. I.
Vaughn Machinery Co., Cuyahoga Falls, O

DRUMS—Flange Steel
Stevens Metal Products Co., Niles, O.

DRUMS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

ENGINEERS—Consulting Wire Mill
Hartley, George D., Worcester, Mass.
Lewis, Kenneth B., Worcester, Mass.

EQUIPMENT—Insulation Testing
Davis, R. L., Electric Co., Wallingford, Conn.
Entwistle, James L., Pawtucket, R. I.

EYELETS—Brass or Zinc
Platt Bros. & Co., The, Waterbury, Conn.

FLASH BAKER—
Carl-Mayer Corp., The, Cleveland, Ohio

FURNACES—Annealing
Carl-Mayer Corp., The, Cleveland, O.
Drever Co., The, Philadelphia, Pa.
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Automatic
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Brazing
Electric Furnace Co., Salem, O.
Firth-Sterling Steel Co., McKeesport, Pa.

FURNACES—Bright Annealing
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Electric
Electric Furnace Co., Salem, O.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Hardening and Tempering
Carl Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, O.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Lead Melting
Electric Furnace Co., Salem, O.
Robertson, John, Co., Brooklyn, N. Y.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Non-Oxidizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, O.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Normalizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, O.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Salt Bath
Electric Furnace Co., Salem, O.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Wire, Strip & Sheet
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, O.
Surface Combustion Corp., Toledo, Ohio.

GALVANIZING EQUIPMENT—
Lee Wilson Engineering Co., Cleveland, Ohio

GEARS—Wire Mill
Farrel-Birmingham Co., Ansonia, Conn.

GRINDERS—ROLL
Farrel-Birmingham Co., Ansonia, Conn.
Norton Co., Worcester, Mass.

HI-SPEED BAKERS—
Carl-Mayer Corp., The, Cleveland, Ohio.

HOISTS—Electric Traveling
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio.

INHIBITORS—
American Chemical Paint Co., Ambler, Pa.
National Oil Products Co., Harrison, N. J.

INSTRUMENTS—Electrical
Entwistle, James L., Pawtucket, R. I.

LATHES—Die Reaming
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

LUBRICANTS—For Metal Cutting, Cleaning, Stamping and Drawing
Magnus Chemical Co., Garwood, N. J.
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

LUBRICANTS—Wire Drawing
Magnus Chemical Co., Garwood, N. J.
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

MACHINERY—Armoring (Cable, Wire Hose)
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Robertson, John, Co., Brooklyn, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Braiding
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Brazing
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.

MACHINERY—Bunching
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cable, Electric
American Insulating Mach'y. Co., Phila., Pa.
Entwistle, James L., Pawtucket, R. I.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Chain Making
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Closing
New England Butt Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Coil Winding
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Coilers
Broden Construction Co., Cleveland, O.
Entwistle, James L., Pawtucket, R. I.
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
New England Butt Co., Providence, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Copper Wire Drawing and Rolling
Farrel-Birmingham Co., Ansonia, Conn.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

MACHINERY—Covering Wire
Fidelity Machine Co., Philadelphia, Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Cutting
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
Moslo Machinery Inc., Cleveland, O.
National Machinery Exchange (Used), New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Shuster, F. B., Co., New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Die Making
Firth-Sterling Steel Co., McKeesport, Pa.

MACHINERY—Draw Benches
Standard Machinery Co., Providence, R. I.

MACHINERY—Edging
Standard Machinery Co., Providence, R. I.

MACHINERY—Enameling
American Insulating Mach'y. Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Extruding
Robertson, John, Co., Brooklyn, N. Y.
Royle, John & Sons, Paterson, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Flat Wire
Broden Construction Co., Cleveland, O.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

WHERE TO BUY, Continued

MACHINERY—Forming
National Machinery Exchange (Used), New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Galvanizing
Lee Wilson Engineering Co., Cleveland, Ohio

MACHINERY—Galvanizing Wire
Broden Construction Co., Cleveland, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Gang Winders
Fidelity Machine Co., Philadelphia, Pa.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grinding
Norton Co., Worcester, Mass.

MACHINERY—Insulating
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Knitting
Fidelity Machine Co., Philadelphia, Pa.

MACHINERY—Lead Encasing
Robertson, John, Co., Brooklyn, N. Y.

MACHINERY—Lead Stripping
Robertson, John, Co., Brooklyn, N. Y.
Watson Machine Co., Paterson, N. J.

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Magnet Wire
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Material Handling
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio.

MACHINERY — Measuring Wire & Cable
Davis, R. L., Electric Co., Wallingford, Conn.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Glader, Wm., Machine Works Co., Chicago, Ill.
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Panning
American Insulating Mach'y. Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Paper Covering Wire
Terkelsen Machine Co., Boston, Mass.

MACHINERY—Pointing
Broden Construction Co., Cleveland, O.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

MACHINERY—Rod Mill
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.

MACHINERY—Rolling Mill
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (Used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

MACHINERY—Rubber for Insulating Wire
Farrel-Birmingham Co., Ansonia, Conn.
National Rubber Machinery Co., Akron, O.
Royle, John & Sons, Paterson, N. J.

MACHINERY—Rubber Strip Covering
Farrel-Birmingham Co., Ansonia, Conn.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Rubber Tubing and Straining
Farrel-Birmingham Co., Ansonia, Conn.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Royle, John, & Sons, Paterson, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Screw Wire
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Worcester, Mass.

MACHINERY—Special
American Insulating Mach'y. Co., Phila., Pa.
Broden Construction Co., Cleveland, O.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I. (Special Designs)
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Spooling
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Spring Making
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Staple
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Broden Construction Co., Cleveland, O.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
Moslo Machinery, Inc., Cleveland, O.
National Machinery Exchange (Used), New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Ruesch, H. J., Machine Co., Newark, N. J.
Shuster, F. B., Co., New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Stranding
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Steel
Broden Construction Co., Cleveland, O.
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Swaging
National Machinery Exchange (Used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

MACHINERY—Taping
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Testing
Entwistle, James L., Pawtucket, R. I.
Scott, Henry L., Co., Providence, R. I.

MACHINERY—Testing Size of Wire
Davis, R. L., Electric Co., Wallingford, Conn.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Testing—Spring
Standard Machinery Co., Providence, R. I.

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y. Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Trolley Wire
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Welding Wire
Eisler Engineering Co., Inc., Newark, N. J.
Igoe Bros., Inc., Newark, N. J.
Micro Products Co., Chicago, Ill.
Shuster, F. B., Co., New Haven, Conn.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.

MACHINERY—Winding
American Insulating Mach'y. Co., Phila., Pa.
Entwistle, James L., Pawtucket, R. I.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt, Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Drawing
American Insulating Mach'y. Co., Phila., Pa.
Broden Construction Co., Cleveland, O.
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (Used), New York, N. Y.
Reactive Wire Drawing, Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

MACHINERY—Wire Measuring
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Rope
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Tinning
American Insulating Mach'y. Co., Phila., Pa.
New England Butt, Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Wood Screw
National Machinery Exchange (Used), New York, N. Y.

MACHINERY—Wrapping Wire
Terkelsen Machine Co., Boston, Mass.

MATERIAL HANDLING EQUIPMENT—
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio.

MILLS—Tandem Rolling and Edging
Standard Machinery Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.

NICKEL SILVER AND PHOSPHOR BRONZE—Rod, Wire and Strip
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

OILS—Wire Drawing
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

OVENS—Industrial
Carl-Mayer Corp., Cleveland, Ohio.
Ross, J. O., Engineering Corp., New York, N. Y.

PANS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

WHERE TO BUY, Continued

PAPER—Creped Wrapping
Crepe-Kraft Co., Inc., Newark, N. J.

PAPER TESTERS—
Scott, Henry L., Co., Providence, R. I.

PATENT ATTORNEYS—
Lancaster, Allwine and Rommel, Washington, D. C.

PICKLING COMPOUNDS
American Chemical Paint Co., Ambler, Pa.
National Oil Products Co., Harrison, N. J.

PLASTIC TESTERS—
Scott, Henry L., Co., Providence, R. I.

POTS—Lead Melting
Farrel-Birmingham Co., Ansonia, Conn.
Robertson, John, Co., Brooklyn, N. Y.

PRESSES—Hydraulic and Mechanical
Farrel-Birmingham Co., Ansonia, Conn.
Robertson, John, Co., Brooklyn, N. Y.
Standard Machinery Co., Providence, R. I. (Mechanical Only)

PRESSES—Lead
Robertson, John, Co., Brooklyn, N. Y.

PULLERS—Wire
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.

PUMPS—Hydraulic
Robertson, John, Co., Brooklyn, N. Y.

REACTIVE WIRE DRAWING
Reactive Wire Drawing, Worcester, Mass.

RECORDERS—Fault and Reel
Entwistle, James L., Pawtucket, R. I.

REEL AND TENSION STAND—
Fidelity Machine Co., Philadelphia, Pa.
Moslo Machinery, Inc., Cleveland, O.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

REEL CRUTCHES—
Watson Machine Co., Paterson, N. J.

REELS—Annealing and Stranding
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Moslo Machinery, Inc., Cleveland, O.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Shuster, F. B., Co., New Haven, Conn.
Stevens Metal Products Co., Niles, O.

REELS—Steel
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS AND SPOOLS—Shipping and Shop
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS—Takeoff
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Moslo Machinery Inc., Cleveland, O.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Shuster, F. B. Co., New Haven, Conn.
Stevens Metal Products Co., Niles, O.

REELS—Vulcanizing and Impregnating
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Shuster, F. B., Co., New Haven, Conn.
Stevens Metal Products, Co., Niles, O.

REELS—Wire Drawing
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hubbard Spool Co., Chicago, Ill.
Moslo Machinery, Inc., Cleveland, O.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products, Co., Niles, O.

REFRACTORIES—High Temperature
Norton Co., Worcester, Mass.

ROD BAKERS
Carl-Mayer Corp., The, Cleveland, O.
Moslo Machinery, Inc., Cleveland, O.
Ross, J. O., Engineering Corp., New York, N. Y.

RODS—Wire—Non-Ferrous
Hudson Wire Co., Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.
Seymour Mfg. Co., Seymour, Conn.

RODS—Wire—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.

ROLLS—
Farrel-Birmingham Co., Ansonia, Conn.

ROLL STRAIGHTENERS—
Moslo Machinery, Inc., Cleveland, O.

RUBBER AND RUBBER COMPRESSION TESTERS—
Scott, Henry L., Co., Providence, R. I.

RUST PROOF COMPOUND—
American Lanolin Co., Lawrence, Mass.

SHEET—Steel
Jones & Laughlin Steel Corp., Pittsburgh, Pa.

SKIN PROTECTOR—
Magnus Chemical Co., Garwood, N. J.

SOAPS—Industrial and Wire Drawing
Magnus Chemical Co., Garwood, N. J.
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

SPARK TESTING EQUIPMENT—
Entwistle, James L., Pawtucket, R. I.

SPOOLS—Annealing and Wire Drawing
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Chicago, Ill.

SPOOLS—Shipping and Shop
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

SPOOLS—Steel
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

STAMPINGS—Steel
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

STRIP—Brass and Non Ferrous
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

STRIP—Steel
Bethlehem Steel Corp., Bethlehem, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.

STRIP METAL TESTERS—
Scott, Henry L., Co., Providence, R. I.

SWIFTS—Take-off
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.

TAKE-UPS FOR CABLE, HOSE, LEAD PRESSES AND SHEET RUBBER—
Entwistle, James L., Pawtucket, R. I.

TANKS—Acid
Hauser-Stander Tank Co., Cincinnati, O.

TANKS—Compound
Watson Machine Co., Paterson, N. J.

TANKS—Lead Lined
Hauser-Stander Tank Co., Cincinnati, O.

TANKS—Pickling
Hauser-Stander Tank Co., Cincinnati, O.

TANKS—Rubber Lined
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Pittsburgh Steel Co., Pittsburgh, Pa.

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Seymour Mfg. Co., Seymour, Conn.

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AUTHORS

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ARNOLD, PAULINE, Vice President, Market Research Corp. of America, New York, New York
BARTLETT, GUY, General Electric Company, Schenectady, New York
BELLIS, ALFRED, John Roebling's Sons Company, Trenton, New Jersey
BENSON, D. WARD-, Doncaster, England
BLOUNT, H., Mfg. Engr., Western Electric Company, Baltimore, Maryland
BRALEY, S. A., Ch. Met. Field Engr., Pittsburgh Steel Company, Pittsburgh, Penna.
BROWN, RICHARD E., Publisher, WIRE & WIRE PRODUCTS, Stamford, Conn.
CARTER, L. L., Anaconda Wire & Cable Co., Hastings-on-Hudson, N. Y.
CHAMBERS, C. M., Paris, France
CLARK, E. W., Mech. Engr., Wire & Cable Section, General Electric Company, Schenectady, New York
COURTNEY, JAMES L., London, England
CROWE, H. D., General Cable Corporation, New York, N. Y.
DINSMORE, Lieut. Col. J. P., Judge Advocate's Office, U. S. Army, Washington, D. C.
DOYLE, J. A., Vice Pres., W. S. Rockwell Company, New York, New York
FAZAKERLEY, T. W., A.I.I.A., 8, The Grove, West Wickham, Kent, England
HARTMAN, W. G., Lewis Bolt & Nut Co., Minneapolis, Minn.
HODGE, DR. W. W., Research Fellow, Mellon Institute of Industrial Res., Pittsburgh, Penna.
IMHOFF, WALLACE G., Tech. Dir. of Res., American Hot Dip Galvanizers Assoc., Pittsburgh, Penna.
IPSEN, C. L., Ind. Dept., General Electric Company, Schenectady, New York
JAGIELSKI, OTTO F., Consulting Engr., Lynn, Mass.
KENYON, JOHN N., Instructor, Civil Engineering Dept., Columbia University, New York, N. Y.
LENZ, GEO. P., JR., Met. Dept., Union Drawn Steel Div., Republic Steel Corporation, Massillon, Ohio
LEPAGE, L. J. C., Managing Director, Sambre-Escaut, S. A., Hemizem, Belgium
LEWIS, KENNETH B., Consulting Engr., Worcester, Mass.
LLOYD, RONALD H., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Penna.
LONGWELL, J. R., Chief Engr., Carboloy Company, Inc., Detroit, Michigan
MAHER, F. J., Instructor of Applied Mechanics, Virginia Polytechnic Institute, Blacksburg, Virginia
MANTELL, C. L., Consulting Engr., New York, N. Y.
McCARTHY, B. L., Ch. Met., Wickwire Spencer Steel Co., Buffalo, N. Y.
PETIX, J. M., Engr., J. O. Ross Engineering Corp., New York, N. Y.
PLETTA, D. H., Associate Professor, Virginia Polytechnic Institute, Blacksburg, Virginia
REEDER, A. M., Met. Engr., Jones & Laughlin Steel Corp., Pittsburgh, Penna.
SANDELIN, ROBERT W., Met., Atlantic Steel Company, Atlanta, Georgia
SEE, WALTER GEO., Sales & Service Mgr., Submerged Combustion Co. of America, Hammond, Indiana
STRINGFELLOW, H. A., 311 Main Street, Worcester, Mass.
WASHBURN, D. E., Ch. Chemist, American Lime & Stone Div., Warner Company, Bellefonte, Penna.
WEAVER, C. E., Devl. Engr., General Electric Company, Schenectady, New York
WESTPHAL, F. A., Supt. Wire Mills, Sheffield Steel Corporation, Kansas City, Mo.
WHITE, C. M., Vice Pres. Chg. Oprs., Republic Steel Corporation, Cleveland, Ohio
WHITTEN, J. L., Sales Mgr., Lee Wilson Engineering Co., Cleveland, Ohio
WICKWIRE, CHESTER F., Vice Pres., Wickwire Brothers, Inc., Cortland, New York
WILTRAKIS, JOS. E., Western Electric Company, Kearny, New Jersey
ZUR, JOHN P., Met. Engr., Trauwood Egineering Co., Cleveland, Ohio

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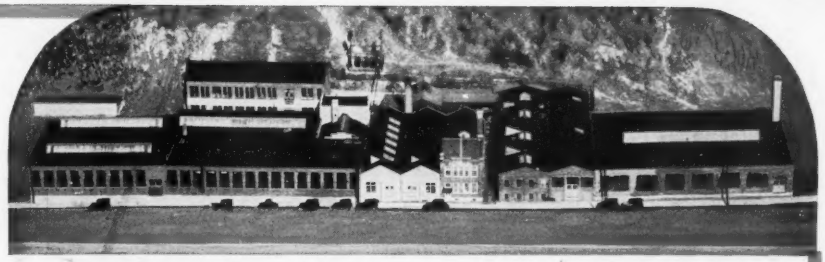

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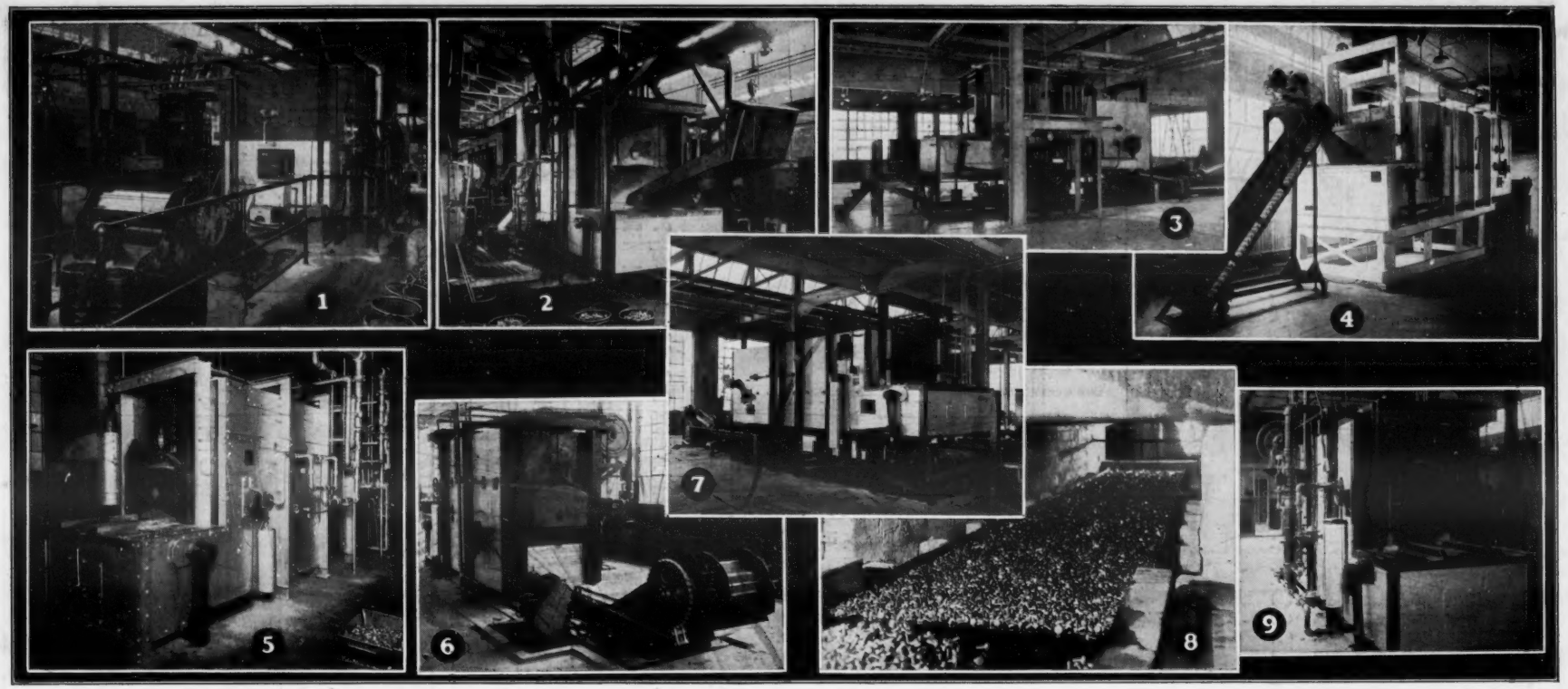

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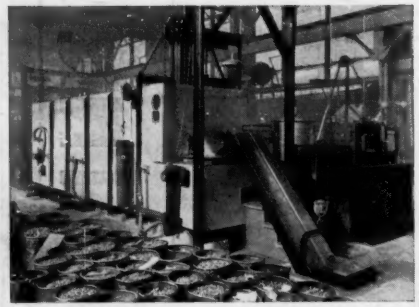

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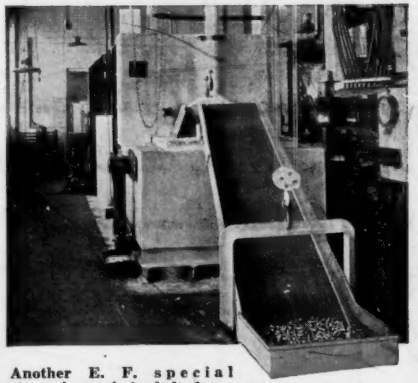

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E. F. controlled atmosphere continuous chain belt conveyor furnace scale-free hardening bolts.

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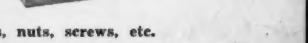

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